OIPE JC81 APR 20 2005 PATENT & TRADEMARK OFFICE



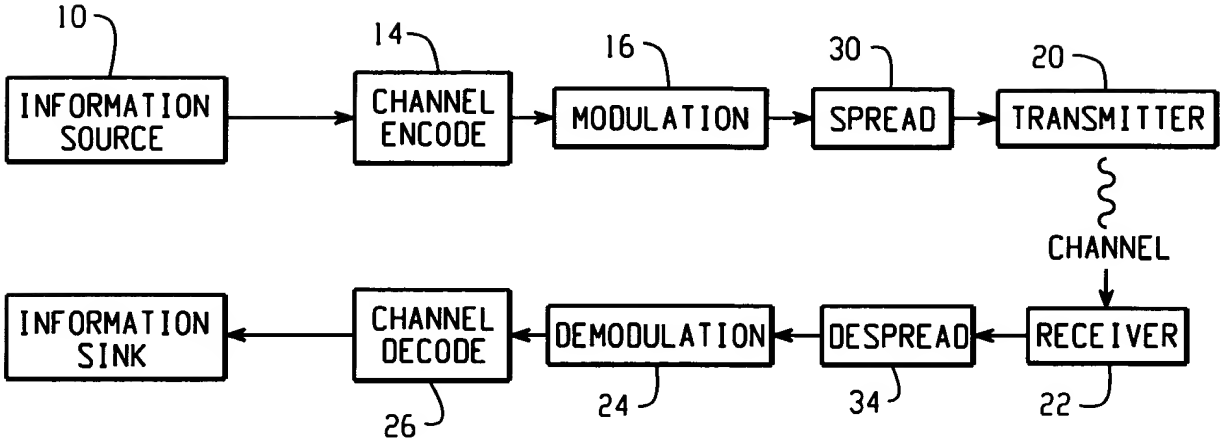


*Fig. 1*
*PRIOR ART*

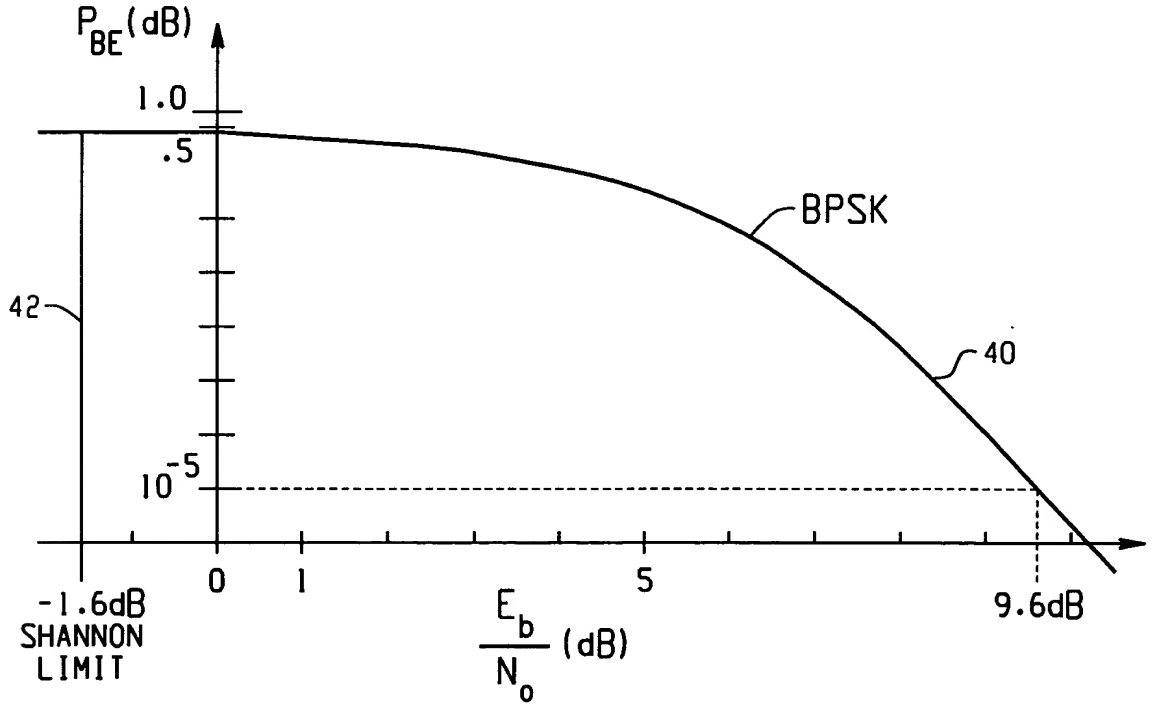


*Fig. 2*
*PRIOR ART*

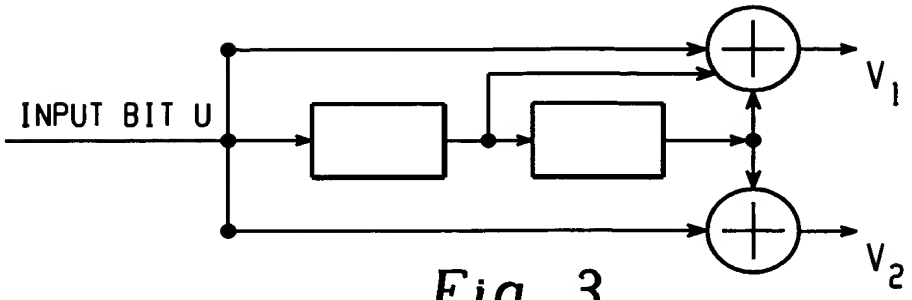


Fig. 3
PRIOR ART

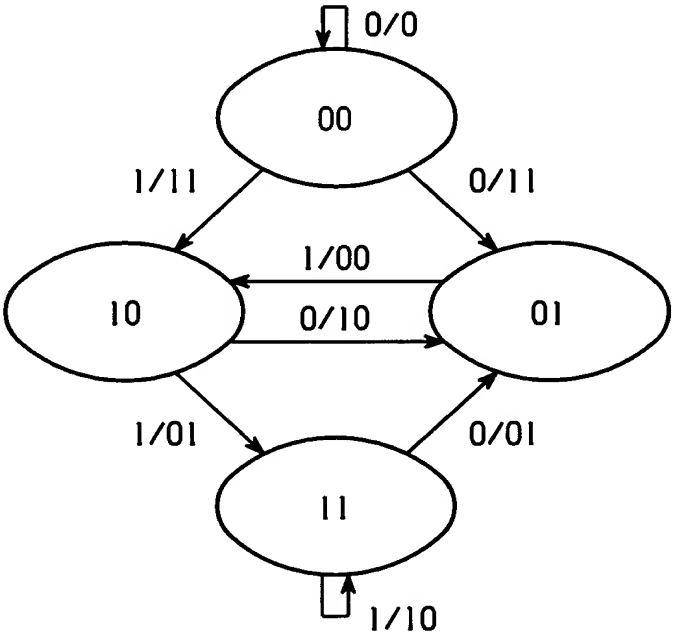


Fig. 4
PRIOR ART

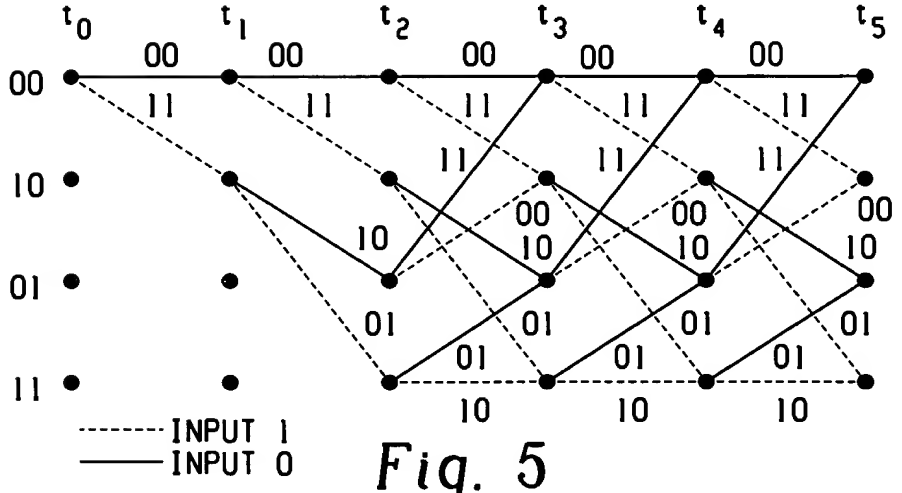


Fig. 5
PRIOR ART

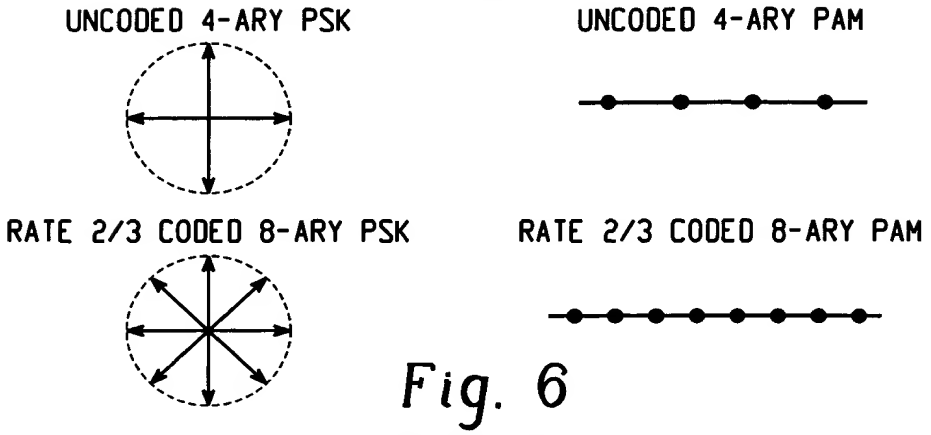


*Fig. 6*
PRIOR ART

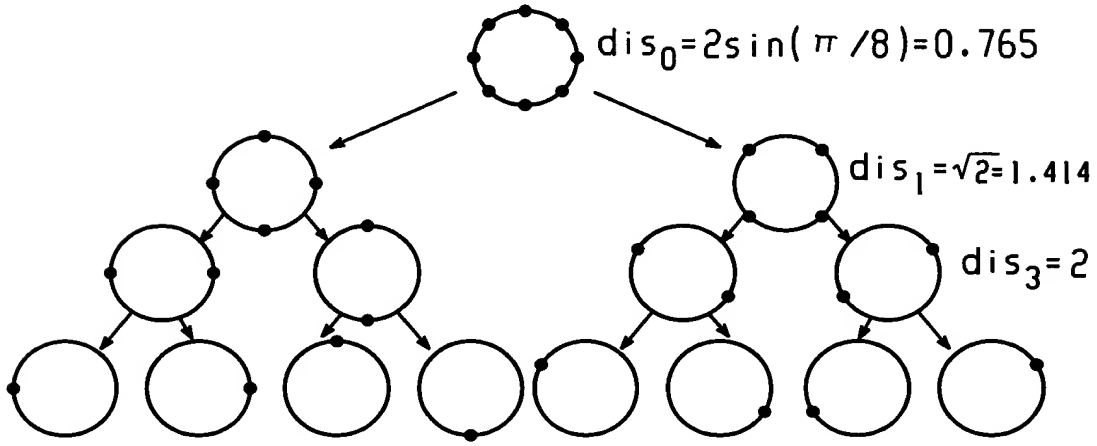


*Fig. 7*
PRIOR ART

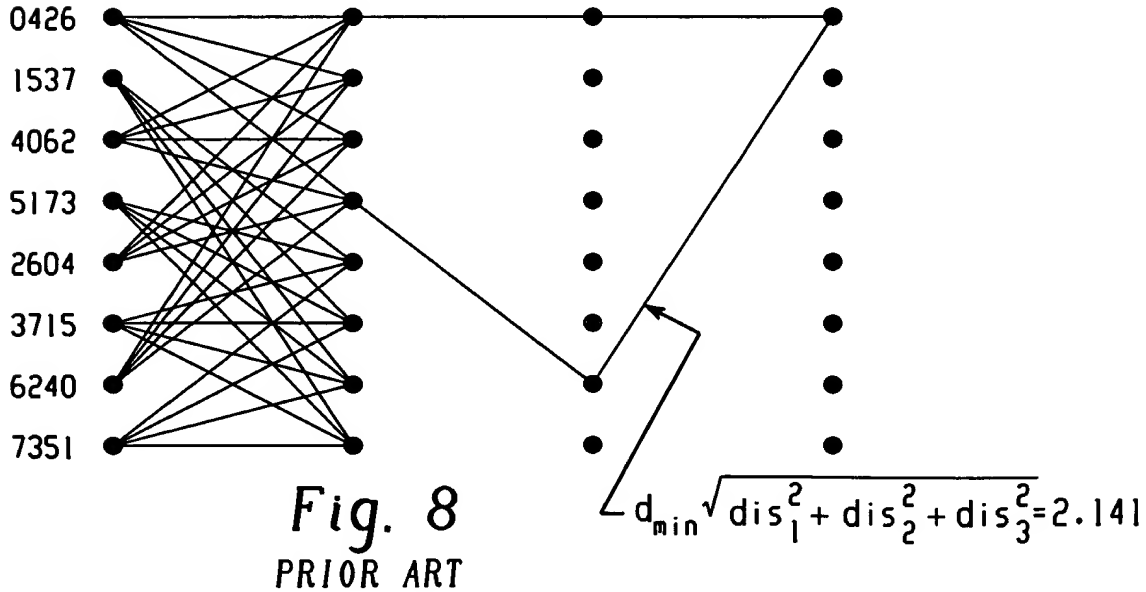


*Fig. 8*
PRIOR ART

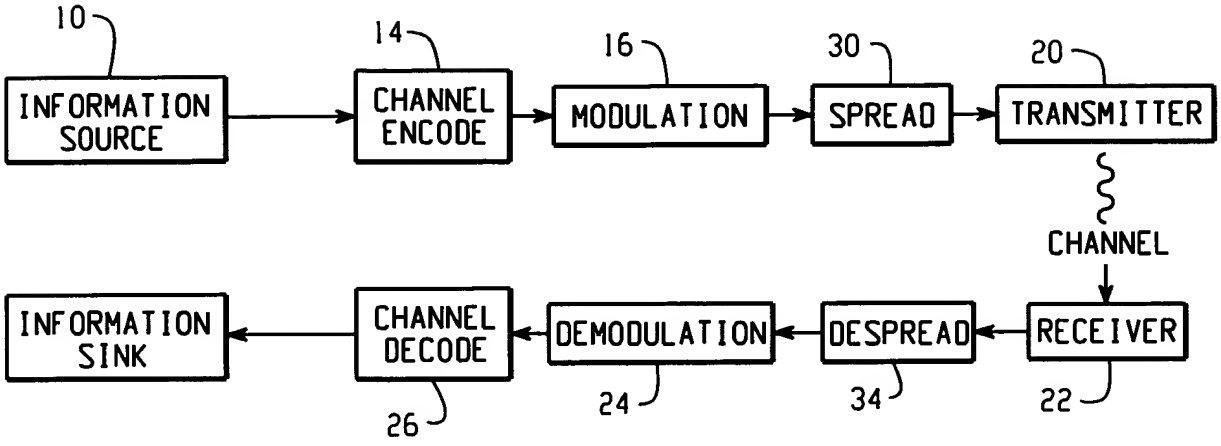


*Fig. 1*
*PRIOR ART*

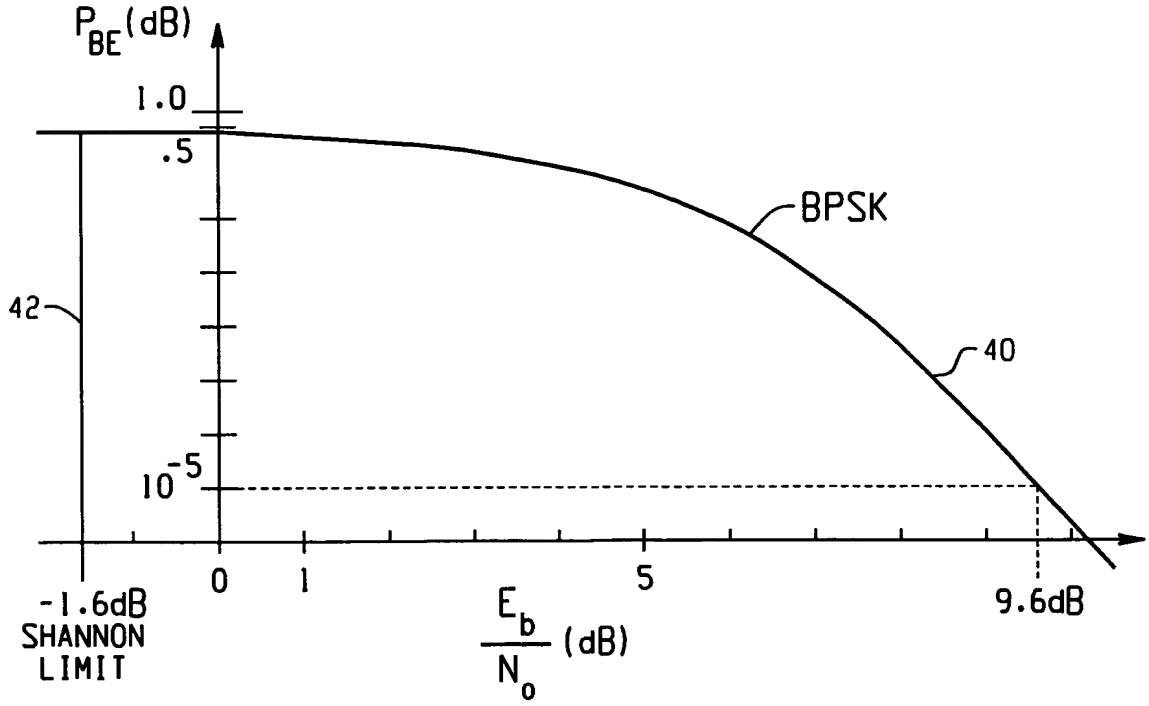


*Fig. 2*
*PRIOR ART*

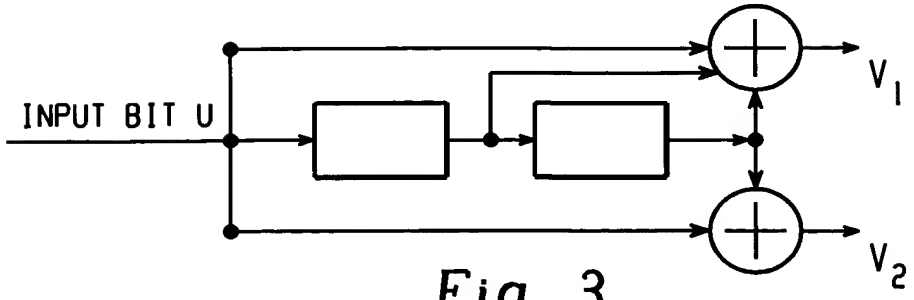


Fig. 3
PRIOR ART

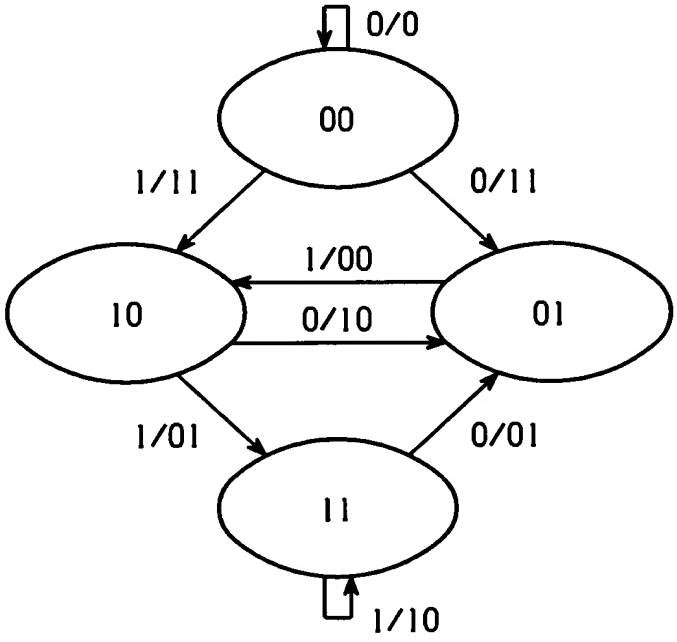


Fig. 4
PRIOR ART

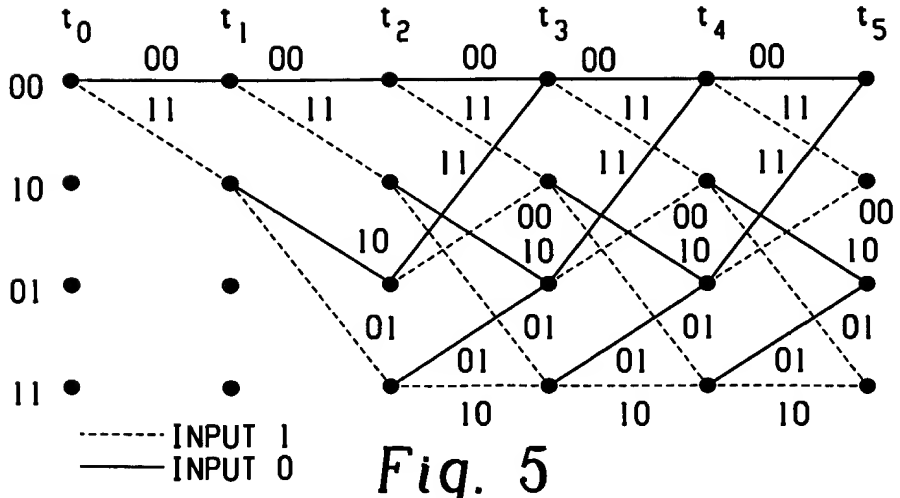


Fig. 5
PRIOR ART

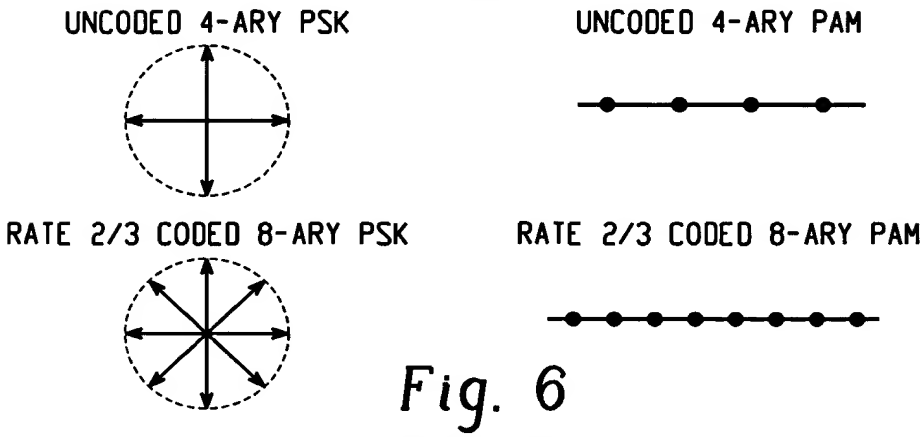


Fig. 6
PRIOR ART

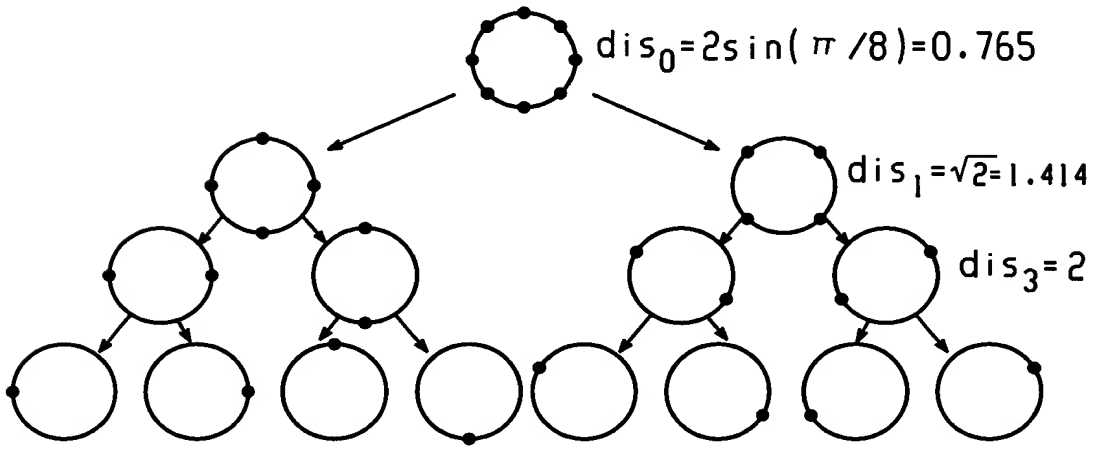


Fig. 7
PRIOR ART

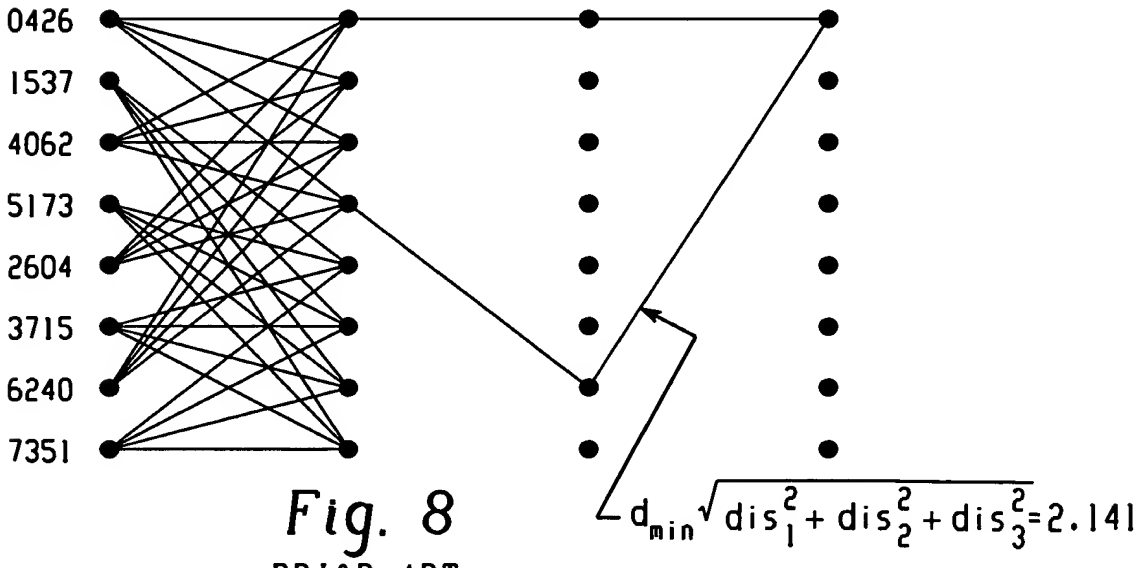


Fig. 8
PRIOR ART

TABLE 1 - STATE TRANSITION TABLE FOR CTCM (4,3)

| STATE | INPUT 0 | INPUT 1 | INPUT 2 | INPUT 3 |
|---|---|---|---|---|
| 1 | 1 | 2 | 5 | 34 |
| 2 | 3 | 8 | 15 | 37 |
| 3 | 4 | 14 | 10 | 50 |
| 4 | 5 | 34 | 1 | 2 |
| 5 | 6 | 26 | 11 | 47 |
| 6 | 7 | 64 | 17 | 25 |
| 7 | 8 | 3 | 37 | 15 |
| 8 | 9 | 28 | 29 | 20 |
| 9 | 10 | 50 | 4 | 14 |
| 10 | 11 | 47 | 6 | 26 |
| 11 | 12 | 63 | 31 | 62 |
| 12 | 13 | 27 | 53 | 55 |
| 13 | 14 | 4 | 50 | 10 |
| 14 | 15 | 37 | 3 | 8 |
| 15 | 16 | 54 | 30 | 43 |
| 16 | 17 | 25 | 7 | 64 |
| 17 | 18 | 35 | 40 | 51 |
| 18 | 19 | 49 | 57 | 42 |
| 19 | 20 | 29 | 28 | 9 |
| 20 | 21 | 58 | 38 | 56 |
| 21 | 22 | 61 | 52 | 24 |
| 22 | 23 | 44 | 32 | 48 |
| 23 | 24 | 52 | 61 | 22 |
| 24 | 25 | 17 | 64 | 7 |
| 25 | 26 | 6 | 47 | 11 |
| 26 | 27 | 13 | 55 | 53 |
| 27 | 28 | 9 | 20 | 29 |
| 28 | 29 | 20 | 9 | 28 |
| 29 | 30 | 43 | 16 | 54 |
| 30 | 31 | 62 | 12 | 63 |
| 31 | 32 | 48 | 23 | 44 |
| 32 | 33 | 36 | 46 | 39 |
| | | | | |

| STATE | INPUT 0 | INPUT 1 | INPUT 2 | INPUT 3 |
|---|---|---|---|---|
| 33 | 34 | 5 | 2 | 1 |
| 34 | 35 | 18 | 51 | 40 |
| 35 | 36 | 33 | 39 | 46 |
| 36 | 37 | 15 | 8 | 3 |
| 37 | 38 | 56 | 21 | 58 |
| 38 | 39 | 46 | 36 | 33 |
| 39 | 40 | 51 | 18 | 35 |
| 40 | 41 | 45 | 59 | 60 |
| 41 | 42 | 57 | 49 | 19 |
| 42 | 43 | 30 | 54 | 16 |
| 43 | 44 | 23 | 48 | 32 |
| 44 | 45 | 41 | 60 | 59 |
| 45 | 46 | 39 | 33 | 36 |
| 46 | 47 | 11 | 26 | 6 |
| 47 | 48 | 32 | 44 | 23 |
| 48 | 49 | 19 | 42 | 57 |
| 49 | 50 | 10 | 14 | 4 |
| 50 | 51 | 40 | 35 | 18 |
| 51 | 52 | 24 | 22 | 61 |
| 52 | 53 | 55 | 13 | 27 |
| 53 | 54 | 16 | 43 | 30 |
| 54 | 55 | 53 | 27 | 13 |
| 55 | 56 | 38 | 58 | 21 |
| 56 | 57 | 42 | 19 | 49 |
| 57 | 58 | 21 | 56 | 38 |
| 58 | 59 | 60 | 41 | 45 |
| 59 | 60 | 59 | 45 | 41 |
| 60 | 61 | 22 | 24 | 52 |
| 61 | 62 | 31 | 63 | 12 |
| 62 | 63 | 12 | 62 | 31 |
| 63 | 64 | 7 | 25 | 17 |
| 64 | 2 | 1 | 34 | 5 |
| | | | | |

Fig. 9

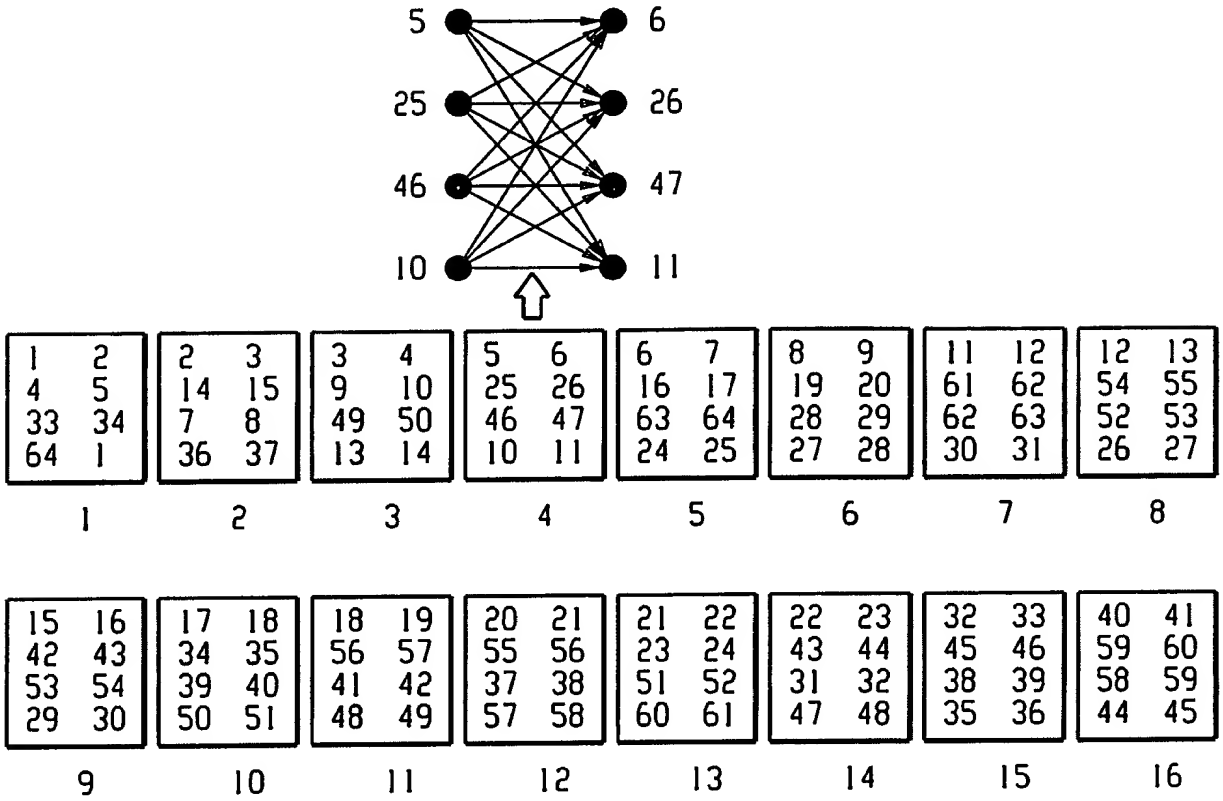
5
25
46
10
6
26
47
11
1 2 4 5 33 34 64 1
2 3 14 15 7 8 36 37
3 4 9 10 49 50 13 14
5 6 25 26 46 47 10 11
6 7 16 17 63 64 24 25
8 9 19 20 28 29 27 28
11 12 61 62 62 63 30 31
12 13 54 55 52 53 26 27
1
2
3
4
5
6
7
8
15 16 42 43 53 54 29 30
17 18 34 35 39 40 50 51
18 19 56 57 41 42 48 49
20 21 55 56 37 38 57 58
21 22 23 24 51 52 60 61
22 23 43 44 31 32 47 48
32 33 45 46 38 39 35 36
40 41 59 60 58 59 44 45
9
10
11
12
13
14
15
16

*Fig. 10*

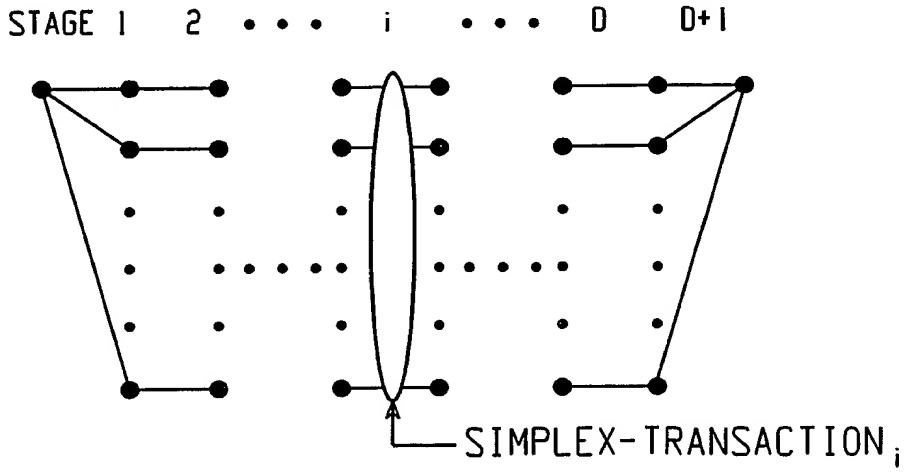
STAGE 1 2 • • • i • • • D D+1
SIMPLEX-TRANSACTION$_i$

*Fig. 11*

| | | | | |
|---|---|---|---|---|
| 1 | 1 | 1 | 1 | 1 |
| 1 | 2 | 3 | 4 | 1 |
| 1 | 5 | 6 | 64 | 1 |
| 1 | 34 | 35 | 33 | 1 |
| 2 | 3 | 4 | 1 | 2 |
| 2 | 8 | 9 | 4 | 2 |
| 2 | 15 | 16 | 64 | 2 |
| 2 | 37 | 38 | 33 | 2 |
| 3 | 4 | 1 | 2 | 3 |
| 3 | 14 | 3 | 14 | 3 |
| 3 | 10 | 6 | 7 | 3 |
| 3 | 50 | 35 | 36 | 3 |
| 4 | 5 | 26 | 13 | 4 |
| 4 | 34 | 18 | 49 | 4 |
| 4 | 1 | 2 | 3 | 4 |
| 4 | 2 | 8 | 9 | 4 |
| 5 | 6 | 64 | 1 | 5 |
| 5 | 26 | 13 | 4 | 5 |
| 5 | 11 | 63 | 64 | 5 |
| 5 | 47 | 32 | 33 | 5 |
| 6 | 7 | 3 | 10 | 6 |
| 6 | 64 | 1 | 5 | 6 |
| 6 | 17 | 35 | 46 | 6 |
| 6 | 25 | 6 | 25 | 6 |
| 7 | 8 | 29 | 16 | 7 |
| 7 | 3 | 10 | 6 | 7 |
| 7 | 37 | 21 | 24 | 7 |
| 7 | 15 | 30 | 63 | 7 |
| 8 | 9 | 4 | 2 | 8 |
| 8 | 28 | 9 | 14 | 8 |
| 8 | 29 | 16 | 7 | 8 |
| 8 | 20 | 38 | 36 | 8 |
| 9 | 10 | 26 | 27 | 9 |
| 9 | 50 | 18 | 19 | 9 |
| 9 | 4 | 2 | 8 | 9 |
| 9 | 14 | 8 | 28 | 9 |
| 10 | 11 | 12 | 13 | 10 |
| 10 | 47 | 48 | 49 | 10 |

| | | | | |
|---|---|---|---|---|
| 10 | 6 | 7 | 3 | 10 |
| 10 | 26 | 27 | 9 | 10 |
| 11 | 12 | 13 | 10 | 11 |
| 11 | 63 | 64 | 5 | 11 |
| 11 | 31 | 32 | 46 | 11 |
| 11 | 62 | 63 | 25 | 11 |
| 12 | 13 | 10 | 11 | 12 |
| 12 | 27 | 29 | 30 | 12 |
| 12 | 53 | 30 | 62 | 12 |
| 12 | 55 | 21 | 61 | 12 |
| 13 | 14 | 15 | 54 | 13 |
| 13 | 4 | 5 | 26 | 13 |
| 13 | 50 | 51 | 52 | 13 |
| 13 | 10 | 11 | 12 | 13 |
| 14 | 15 | 54 | 13 | 14 |
| 14 | 37 | 56 | 49 | 14 |
| 14 | 3 | 14 | 3 | 14 |
| 14 | 8 | 28 | 9 | 14 |
| 15 | 16 | 64 | 2 | 15 |
| 15 | 54 | 13 | 14 | 15 |
| 15 | 30 | 63 | 7 | 15 |
| 15 | 43 | 32 | 36 | 15 |
| 16 | 17 | 18 | 42 | 16 |
| 16 | 25 | 26 | 53 | 16 |
| 16 | 7 | 8 | 29 | 16 |
| 16 | 64 | 2 | 15 | 16 |
| 17 | 18 | 42 | 16 | 17 |
| 17 | 35 | 46 | 6 | 17 |
| 17 | 40 | 60 | 24 | 17 |
| 17 | 51 | 61 | 63 | 17 |
| 18 | 19 | 9 | 50 | 18 |
| 18 | 49 | 4 | 34 | 18 |
| 18 | 57 | 38 | 39 | 18 |
| 18 | 42 | 16 | 17 | 18 |
| 19 | 20 | 58 | 41 | 19 |
| 19 | 29 | 43 | 48 | 19 |
| 19 | 28 | 20 | 56 | 19 |
| 19 | 9 | 50 | 18 | 19 |

| | | | | |
|---|---|---|---|---|
| 20 | 21 | 52 | 27 | 20 |
| 20 | 58 | 41 | 19 | 20 |
| 20 | 38 | 36 | 8 | 20 |
| 20 | 56 | 19 | 28 | 20 |
| 21 | 22 | 48 | 57 | 21 |
| 21 | 61 | 12 | 55 | 21 |
| 21 | 52 | 27 | 20 | 21 |
| 21 | 24 | 7 | 37 | 21 |
| 22 | 23 | 22 | 23 | 22 |
| 22 | 44 | 59 | 60 | 22 |
| 22 | 32 | 39 | 51 | 22 |
| 22 | 48 | 57 | 21 | 22 |
| 23 | 24 | 25 | 47 | 23 |
| 23 | 52 | 53 | 43 | 23 |
| 23 | 61 | 62 | 31 | 23 |
| 23 | 22 | 23 | 22 | 23 |
| 24 | 25 | 47 | 23 | 24 |
| 24 | 17 | 40 | 60 | 24 |
| 24 | 64 | 34 | 51 | 24 |
| 24 | 7 | 37 | 21 | 24 |
| 25 | 26 | 53 | 16 | 25 |
| 25 | 6 | 25 | 6 | 25 |
| 25 | 47 | 23 | 24 | 25 |
| 25 | 11 | 62 | 63 | 25 |
| 26 | 27 | 9 | 10 | 26 |
| 26 | 13 | 4 | 5 | 26 |
| 26 | 55 | 38 | 46 | 26 |
| 26 | 53 | 16 | 25 | 26 |
| 27 | 28 | 29 | 54 | 27 |
| 27 | 9 | 10 | 26 | 27 |
| 27 | 20 | 21 | 52 | 27 |
| 27 | 29 | 30 | 12 | 27 |
| 28 | 29 | 54 | 27 | 28 |
| 28 | 20 | 56 | 19 | 28 |
| 28 | 9 | 14 | 8 | 28 |
| 28 | 28 | 28 | 28 | 28 |
| 29 | 30 | 12 | 27 | 29 |
| 29 | 43 | 48 | 19 | 29 |

Fig. 12A

| | | | | |
|---|---|---|---|---|
| 29 | 16 | 7 | 8 | 29 |
| 29 | 54 | 27 | 28 | 29 |
| 30 | 31 | 48 | 42 | 30 |
| 30 | 62 | 12 | 53 | 30 |
| 30 | 12 | 27 | 29 | 30 |
| 30 | 63 | 7 | 15 | 30 |
| 31 | 32 | 46 | 11 | 31 |
| 31 | 48 | 42 | 30 | 31 |
| 31 | 23 | 61 | 62 | 31 |
| 31 | 44 | 60 | 61 | 31 |
| 32 | 33 | 5 | 47 | 32 |
| 32 | 36 | 15 | 43 | 32 |
| 32 | 46 | 11 | 31 | 32 |
| 32 | 39 | 51 | 22 | 32 |
| 33 | 34 | 40 | 45 | 33 |
| 33 | 5 | 47 | 32 | 33 |
| 33 | 2 | 37 | 38 | 33 |
| 33 | 1 | 34 | 35 | 33 |
| 34 | 35 | 33 | 1 | 34 |
| 34 | 18 | 49 | 4 | 34 |
| 34 | 51 | 24 | 64 | 34 |
| 34 | 40 | 45 | 33 | 34 |
| 35 | 36 | 3 | 50 | 35 |
| 35 | 33 | 1 | 34 | 35 |
| 35 | 39 | 35 | 39 | 35 |
| 35 | 46 | 6 | 17 | 35 |
| 36 | 37 | 58 | 45 | 36 |
| 36 | 15 | 43 | 32 | 36 |
| 36 | 8 | 20 | 38 | 36 |
| 36 | 3 | 50 | 35 | 36 |
| 37 | 38 | 33 | 2 | 37 |
| 37 | 56 | 49 | 14 | 37 |
| 37 | 21 | 24 | 7 | 37 |
| 37 | 58 | 45 | 36 | 37 |
| 38 | 39 | 18 | 57 | 38 |
| 38 | 46 | 26 | 55 | 38 |
| 38 | 36 | 8 | 20 | 38 |
| 38 | 33 | 2 | 37 | 38 |

| | | | | |
|---|---|---|---|---|
| 39 | 40 | 59 | 45 | 39 |
| 39 | 51 | 22 | 32 | 39 |
| 39 | 18 | 57 | 38 | 39 |
| 39 | 35 | 39 | 35 | 39 |
| 40 | 41 | 49 | 50 | 40 |
| 40 | 45 | 33 | 34 | 40 |
| 40 | 59 | 45 | 39 | 40 |
| 40 | 60 | 24 | 17 | 40 |
| 41 | 42 | 43 | 44 | 41 |
| 41 | 57 | 58 | 59 | 41 |
| 41 | 49 | 50 | 40 | 41 |
| 41 | 19 | 20 | 58 | 41 |
| 42 | 43 | 44 | 41 | 42 |
| 42 | 30 | 31 | 48 | 42 |
| 42 | 54 | 55 | 56 | 42 |
| 42 | 16 | 17 | 18 | 42 |
| 43 | 44 | 41 | 42 | 43 |
| 43 | 23 | 52 | 53 | 43 |
| 43 | 48 | 19 | 29 | 43 |
| 43 | 32 | 36 | 15 | 43 |
| 44 | 45 | 46 | 47 | 44 |
| 44 | 41 | 42 | 43 | 44 |
| 44 | 60 | 61 | 31 | 44 |
| 44 | 59 | 60 | 22 | 44 |
| 45 | 46 | 47 | 44 | 45 |
| 45 | 39 | 40 | 59 | 45 |
| 45 | 33 | 34 | 40 | 45 |
| 45 | 36 | 37 | 58 | 45 |
| 46 | 47 | 44 | 45 | 33 |
| 46 | 11 | 31 | 32 | 34 |
| 46 | 26 | 55 | 38 | 34 |
| 46 | 6 | 17 | 35 | 34 |
| 47 | 48 | 49 | 10 | 34 |
| 47 | 32 | 33 | 5 | 35 |
| 47 | 44 | 45 | 46 | 35 |
| 47 | 23 | 24 | 25 | 35 |
| 48 | 49 | 10 | 47 | 35 |
| 48 | 19 | 29 | 43 | 36 |

Fig. 12B

| | | | | |
|---|---|---|---|---|
| 48 | 42 | 30 | 31 | 36 |
| 48 | 57 | 21 | 22 | 36 |
| 49 | 50 | 40 | 41 | 36 |
| 49 | 10 | 47 | 48 | 37 |
| 49 | 14 | 37 | 56 | 37 |
| 49 | 4 | 34 | 18 | 37 |
| 50 | 51 | 52 | 13 | 37 |
| 50 | 40 | 41 | 49 | 38 |
| 50 | 35 | 36 | 3 | 38 |
| 50 | 18 | 19 | 9 | 38 |
| 51 | 52 | 13 | 50 | 38 |
| 51 | 24 | 64 | 34 | 39 |
| 51 | 22 | 32 | 39 | 39 |
| 51 | 61 | 63 | 17 | 39 |
| 52 | 53 | 43 | 23 | 39 |
| 52 | 55 | 58 | 60 | 40 |
| 52 | 13 | 50 | 51 | 40 |
| 52 | 27 | 20 | 21 | 40 |
| 53 | 54 | 53 | 54 | 40 |
| 53 | 16 | 25 | 26 | 41 |
| 53 | 43 | 23 | 52 | 41 |
| 53 | 30 | 62 | 12 | 41 |
| 54 | 55 | 56 | 42 | 41 |
| 54 | 53 | 54 | 53 | 42 |
| 54 | 27 | 28 | 29 | 42 |
| 54 | 13 | 14 | 15 | 42 |
| 55 | 56 | 42 | 54 | 42 |
| 55 | 38 | 46 | 26 | 43 |
| 55 | 58 | 60 | 52 | 43 |
| 55 | 21 | 61 | 12 | 43 |
| 56 | 57 | 56 | 57 | 43 |
| 56 | 42 | 54 | 55 | 44 |
| 56 | 19 | 28 | 20 | 44 |
| 56 | 49 | 14 | 37 | 44 |
| 57 | 58 | 59 | 41 | 44 |
| 57 | 21 | 22 | 48 | 45 |
| 57 | 56 | 57 | 56 | 45 |
| 57 | 38 | 39 | 18 | 45 |

| | | | | |
|---|---|---|---|---|
| 58 | 59 | 41 | 57 | 45 |
| 58 | 60 | 52 | 55 | 33 |
| 58 | 41 | 19 | 20 | 34 |
| 58 | 45 | 36 | 37 | 34 |
| 59 | 60 | 22 | 44 | 34 |
| 59 | 59 | 59 | 59 | 34 |
| 59 | 45 | 39 | 40 | 35 |
| 59 | 41 | 57 | 58 | 35 |
| 60 | 61 | 31 | 44 | 35 |
| 60 | 22 | 44 | 59 | 35 |
| 60 | 24 | 17 | 40 | 36 |
| 60 | 52 | 55 | 58 | 36 |
| 61 | 62 | 31 | 23 | 36 |
| 61 | 31 | 44 | 60 | 36 |
| 61 | 63 | 17 | 51 | 37 |
| 61 | 12 | 55 | 21 | 37 |
| 62 | 63 | 25 | 11 | 37 |
| 62 | 12 | 53 | 30 | 37 |
| 62 | 62 | 62 | 62 | 38 |
| 62 | 31 | 23 | 61 | 38 |
| 63 | 64 | 5 | 11 | 38 |
| 63 | 7 | 15 | 30 | 38 |
| 63 | 25 | 11 | 62 | 39 |
| 63 | 17 | 51 | 61 | 39 |
| 64 | 2 | 15 | 16 | 39 |
| 64 | 1 | 5 | 6 | 39 |
| 64 | 34 | 51 | 24 | 40 |
| 64 | 5 | 11 | 63 | 40 |

Fig. 12C

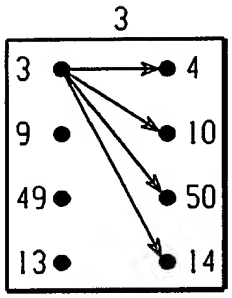


Fig. 13(a)

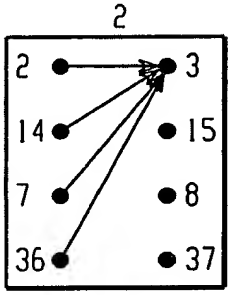


Fig. 13(b)

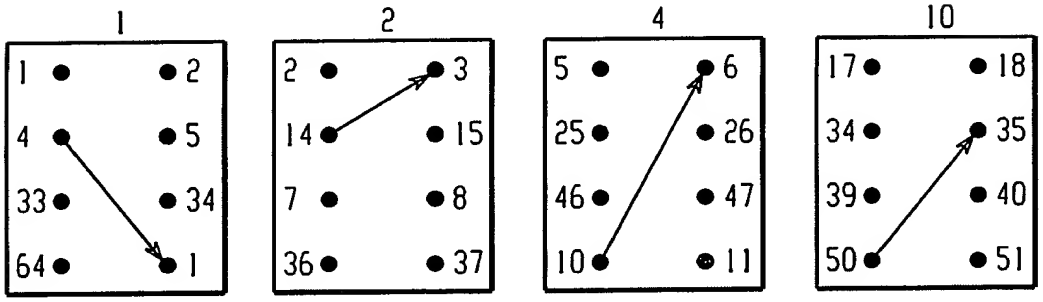


Fig. 13(c)

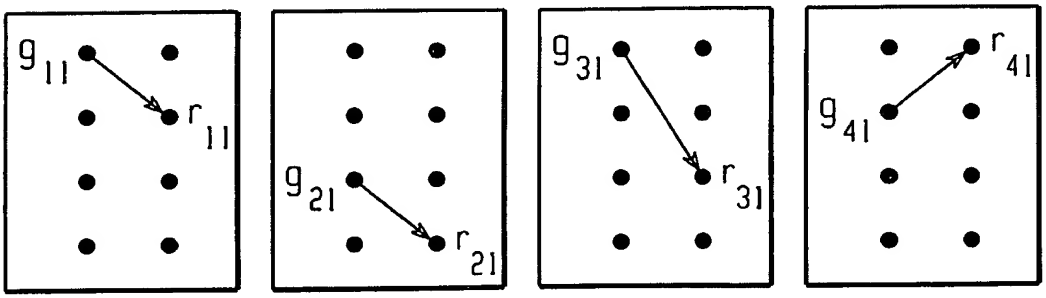


Fig. 14(a)

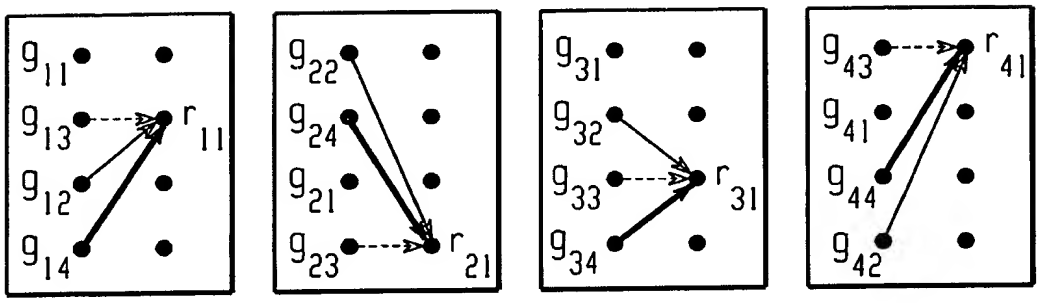


Fig. 14(b)

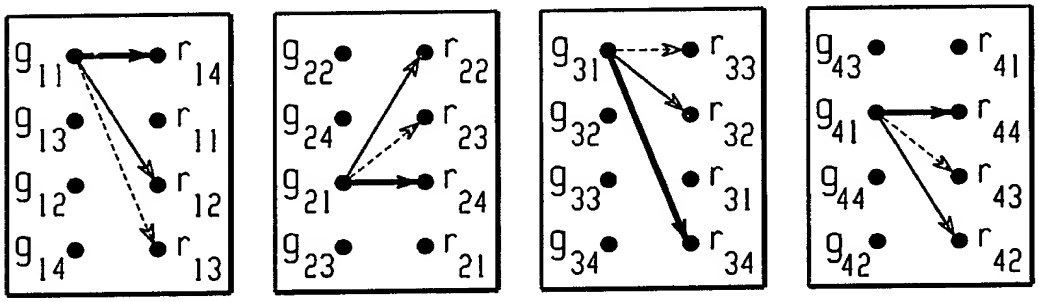


Fig. 14(c)

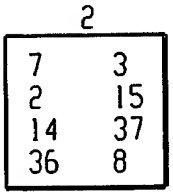


Fig. 15(a)

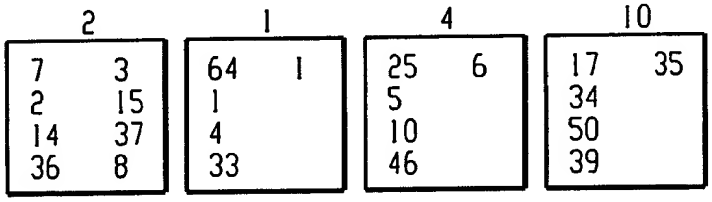


Fig. 15(b)

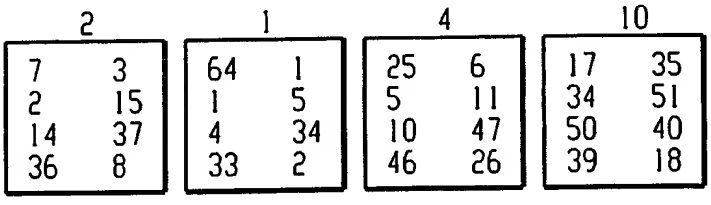


Fig. 15(c)

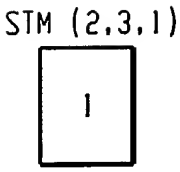


Fig. 16(a)

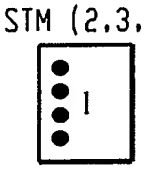


Fig. 16(b)

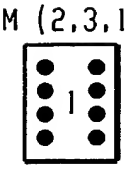


Fig. 16(c)

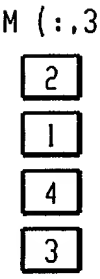


Fig. 16(d)

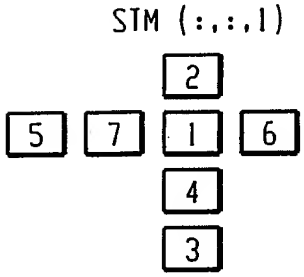


Fig. 16(e)

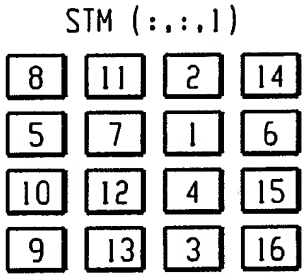


Fig. 16(f)

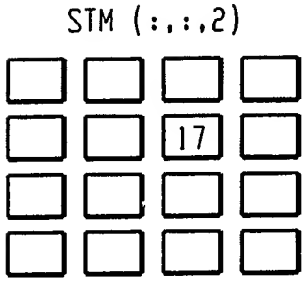


Fig. 16(g)

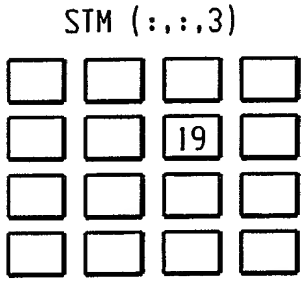


Fig. 16(h)

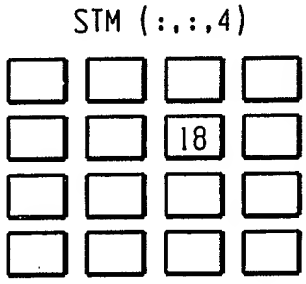


Fig. 16(i)

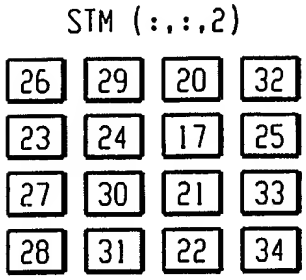


Fig. 16(j)

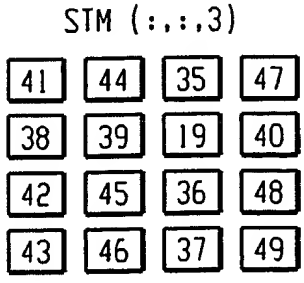


Fig. 16(k)

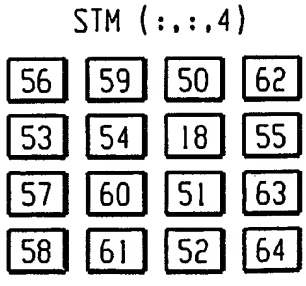


Fig. 16(l)

STM (2,3)

| | |
|---|---|
| 1 | 1 |
| 64 | 2 |
| 4 | 5 |
| 33 | 34 |

Fig. 17(a)

STM (:,3)

| | |
|---|---|
| 2 | 3 |
| 7 | 8 |
| 14 | 15 |
| 36 | 37 |

| | |
|---|---|
| 1 | 1 |
| 64 | 2 |
| 4 | 5 |
| 33 | 34 |

| | |
|---|---|
| 34 | 35 |
| 17 | 18 |
| 50 | 51 |
| 39 | 40 |

| | |
|---|---|
| 5 | 6 |
| 25 | 26 |
| 10 | 11 |
| 46 | 47 |

Fig. 17(b)

STM (:,:)

| | |
|---|---|
| 2 | 3 |
| 7 | 8 |
| 14 | 15 |
| 36 | 37 |

| | |
|---|---|
| 6 | 64 |
| 63 | 7 |
| 16 | 25 |
| 24 | 17 |

| | |
|---|---|
| 3 | 4 |
| 13 | 14 |
| 9 | 10 |
| 49 | 50 |

| | |
|---|---|
| 1 | 1 |
| 64 | 2 |
| 4 | 5 |
| 33 | 34 |

| | |
|---|---|
| 35 | 33 |
| 32 | 36 |
| 38 | 46 |
| 45 | 39 |

| | |
|---|---|
| 34 | 35 |
| 17 | 18 |
| 50 | 51 |
| 39 | 40 |

| | |
|---|---|
| 5 | 6 |
| 25 | 26 |
| 10 | 11 |
| 46 | 47 |

Fig. 17(c)

| | |
|---|---|
| 26 | 13 |
| 12 | 27 |
| 54 | 53 |
| 52 | 55 |

| | |
|---|---|
| 8 | 9 |
| 27 | 28 |
| 28 | 29 |
| 19 | 20 |

| | |
|---|---|
| 2 | 3 |
| 7 | 8 |
| 14 | 15 |
| 36 | 37 |

| | |
|---|---|
| 18 | 49 |
| 48 | 19 |
| 56 | 42 |
| 41 | 57 |

| | |
|---|---|
| 6 | 64 |
| 63 | 7 |
| 16 | 25 |
| 24 | 17 |

| | |
|---|---|
| 3 | 4 |
| 13 | 14 |
| 9 | 10 |
| 49 | 50 |

| | |
|---|---|
| 1 | 1 |
| 64 | 2 |
| 4 | 5 |
| 33 | 34 |

| | |
|---|---|
| 35 | 33 |
| 32 | 36 |
| 38 | 46 |
| 45 | 39 |

| | |
|---|---|
| 47 | 32 |
| 31 | 48 |
| 43 | 23 |
| 22 | 44 |

| | |
|---|---|
| 37 | 38 |
| 55 | 56 |
| 20 | 21 |
| 57 | 58 |

| | |
|---|---|
| 34 | 35 |
| 17 | 18 |
| 50 | 51 |
| 39 | 40 |

| | |
|---|---|
| 40 | 45 |
| 44 | 41 |
| 58 | 60 |
| 59 | 59 |

| | |
|---|---|
| 11 | 63 |
| 62 | 12 |
| 30 | 62 |
| 61 | 31 |

| | |
|---|---|
| 15 | 16 |
| 53 | 54 |
| 29 | 30 |
| 42 | 43 |

| | |
|---|---|
| 5 | 6 |
| 25 | 26 |
| 10 | 11 |
| 46 | 47 |

| | |
|---|---|
| 51 | 24 |
| 23 | 52 |
| 21 | 61 |
| 60 | 22 |

Fig. 17(d)

```
 1  2  3      1  2 -3
 1 -2 -3      1 -2  3
-1  2 -3     -1  2  3
-1 -2  3     -1 -2 -3
```

Fig. 18

```
 1  3  5
-1  4  6
 2 -3 -6
-2 -4 -5
```

Fig. 19(a)

```
 1  3  5    1 -3 -5   -1  3 -5   -1 -3  5
-1  4  6   -1 -4 -6    1  4 -6    1 -4  6
 2 -3 -6    2  3  6   -2 -3  6   -2  3 -6
-2 -4 -5   -2  4  5    2 -4  5    2  4 -5
   (1)        (2)        (3)        (4)
```

Fig. 19(b)

(1,3,5), (1,-3,-5), (-1,3,-5), (-1,-3,5)
(-1,4,6), (-1,-4,-6), (1,4,-6), (1,-4,6)
(2,-3,-6), (2,3,6), (-2,-3,6), (-2,3,-6)
(-2,-4,-5), (-2,4,5), (2,-4,5), (2,4,-5)

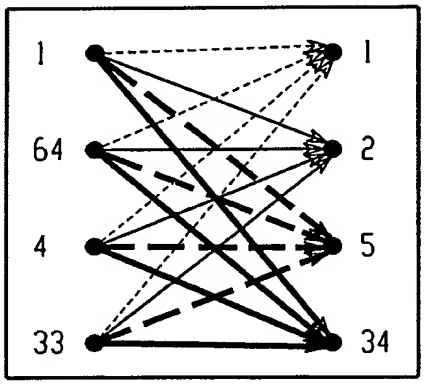


Fig. 20(a)

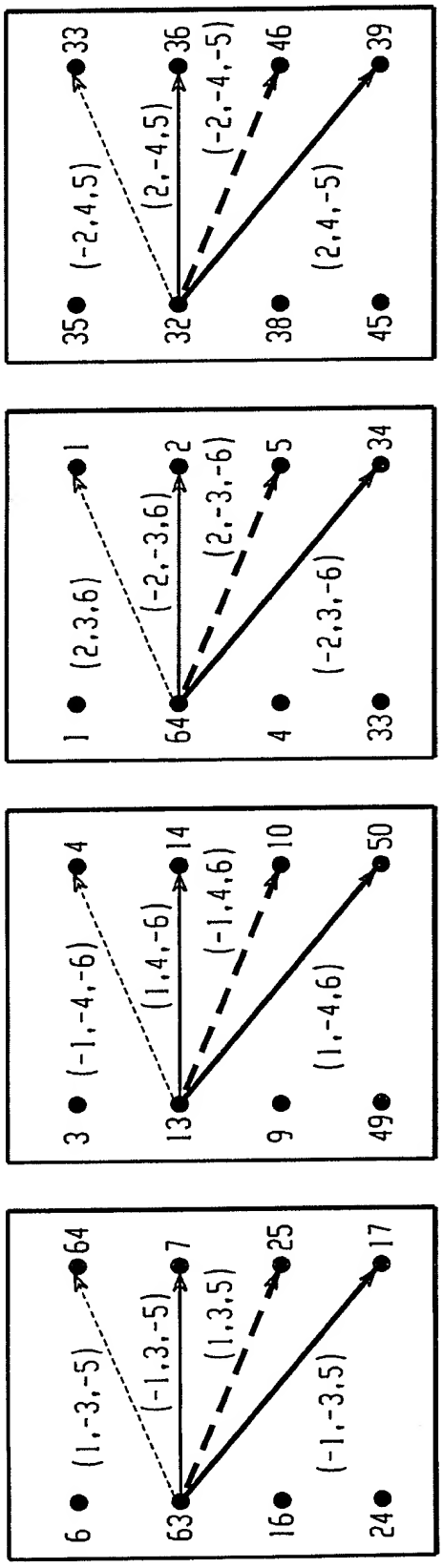
33
(-2,4,5)
35
36
(2,-4,5)
32
46
(-2,-4,5)
38
39
(2,4,-5)
45
1
(2,3,6)
1
2
(-2,-3,6)
64
5
(2,-3,-6)
4
34
(-2,3,-6)
33
4
(-1,-4,-6)
3
14
(1,4,-6)
13
10
(-1,4,6)
9
50
(1,-4,6)
49
64
(1,-3,-5)
6
7
(-1,3,-5)
63
25
(1,3,5)
16
17
(-1,-3,5)
24

Fig. 20 (b)

| | | |
|---|---|---|
| 1 | 3 | 5 |

Fig. 21(a)

| | | |
|---|---|---|
| 1 | 3 | 5 |
| -1 | | |
| | -3 | |
| | | -5 |

Fig. 21(b)

| | | |
|---|---|---|
| 1 | 3 | 5 |
| -1 | 4 | 6 |
| 2 | -3 | -6 |
| -2 | -4 | -5 |

Fig. 21(c)

IIS(:,1,1)

| | | |
|---|---|---|
| 1 | 3 | 5 |
| -1 | 4 | 6 |
| 2 | -3 | -6 |
| -2 | -4 | -5 |
| | | |
| | | |
| | | |

Fig. 22(a)

IIS(:,1,1)

| | | |
|---|---|---|
| 1 | 3 | 5 |
| -1 | 4 | 6 |
| 2 | -3 | -6 |
| -2 | -4 | -5 |
| -1 | | |
| 1 | | |
| -2 | | |
| 2 | | |
| | -3 | |
| | -4 | |
| | 3 | |
| | 4 | |
| | | -5 |
| | | -6 |
| | | 6 |
| | | 5 |

Fig. 22(b)

IIS(:,1,1)

| | | |
|---|---|---|
| 1 | 3 | 5 |
| -1 | 4 | 6 |
| 2 | -3 | -6 |
| -2 | -4 | -5 |
| -1 | 9 | 11 |
| 1 | 10 | 12 |
| -2 | -9 | -12 |
| 2 | -10 | -11 |
| 7 | -3 | -11 |
| -7 | -4 | -12 |
| 8 | 3 | 12 |
| -8 | 4 | 11 |
| -7 | -9 | -5 |
| 7 | -10 | -6 |
| -8 | 9 | 6 |
| 8 | 10 | 5 |

Fig. 22(c)

IIS(:,:,1)

| | | | |
|---|---|---|---|
| 1 3 5<br>-1 4 6<br>2 -3 -6<br>-2 -4 -5 | -1<br>1<br>-2<br>2 | -3<br>-4<br>3<br>4 | -5<br>-6<br>6<br>5 |
| -1 9 11<br>1 10 12<br>-2 -9 -12<br>2 -10 -11 | 1<br>-1<br>2<br>-2 | -9<br>-10<br>9<br>10 | -11<br>-12<br>12<br>11 |
| 7 -3 -11<br>-7 -4 -12<br>8 3 12<br>-8 4 11 | -7<br>7<br>-8<br>8 | 3<br>4<br>-3<br>-4 | 11<br>12<br>-12<br>-11 |
| -7 -9 -5<br>7 -10 -6<br>-8 9 6<br>8 10 5 | 7<br>-7<br>8<br>-8 | 9<br>10<br>-9<br>-10 | 5<br>6<br>-6<br>-5 |

Fig. 22(d)

IIS(:,:,1)

| | | | |
|---|---|---|---|
| 1 3 5<br>-1 4 6<br>2 -3 -6<br>-2 -4 -5 | -1 17 21<br>1 18 22<br>-2 -17 -22<br>2 -18 -21 | 13 -3 -21<br>-13 -4 -22<br>14 3 22<br>-14 4 21 | -13 -17 -5<br>13 -18 -6<br>-14 17 6<br>14 18 5 |
| -1 9 11<br>1 10 12<br>-2 -9 -12<br>2 -10 -11 | 1 19 23<br>-1 20 24<br>2 -19 -24<br>-2 -20 -23 | -13 -9 -23<br>13 -10 -24<br>-14 9 24<br>14 10 23 | 13 -19 -11<br>-13 -20 -12<br>14 19 12<br>-14 20 11 |
| 7 -3 -11<br>-7 -4 -12<br>8 3 12<br>-8 4 11 | -7 -17 -23<br>7 -18 -24<br>-8 17 24<br>8 18 23 | 15 3 23<br>-15 4 24<br>16 -3 -24<br>-16 -4 -23 | -15 17 11<br>15 18 12<br>-16 -17 -12<br>16 -18 -11 |
| -7 -9 -5<br>7 -10 -6<br>-8 9 6<br>8 10 5 | 7 -19 -21<br>-7 -20 -22<br>8 19 22<br>-8 20 21 | -15 9 21<br>15 10 22<br>-16 -9 -22<br>16 -10 -21 | 15 19 5<br>-15 20 6<br>16 -19 -6<br>-16 -20 -5 |

Fig. 22(e)

IIS(:,:,3)

| | | | |
|---|---|---|---|
| -3 | -17 | 3 | 17 |
| -4 | -18 | 4 | 18 |
| 3 | 17 | -3 | -17 |
| 4 | 18 | -4 | -18 |
| -9 | -19 | 9 | 19 |
| -10 | -20 | 10 | 20 |
| 9 | 19 | -9 | -19 |
| 10 | 20 | -10 | -20 |
| 3 | 17 | -3 | -17 |
| 4 | 18 | -4 | -18 |
| -3 | -17 | 3 | 17 |
| -4 | -18 | 4 | 18 |
| 9 | 19 | -9 | -19 |
| 10 | 20 | -10 | -20 |
| -9 | -19 | 9 | 19 |
| -10 | -20 | 10 | 20 |

Fig. 22(g)

IIS(:,:,2)

| | | | |
|---|---|---|---|
| -1 | 1 | -13 | 13 |
| 1 | -1 | 13 | -13 |
| -2 | 2 | -14 | 14 |
| 2 | -2 | 14 | -14 |
| 1 | -1 | 13 | -13 |
| -1 | 1 | -13 | 13 |
| 2 | -2 | 14 | -14 |
| -2 | 2 | -14 | 14 |
| -7 | 7 | -15 | 15 |
| 7 | -7 | 15 | -15 |
| -8 | 8 | -16 | 16 |
| 8 | -8 | 16 | -16 |
| 7 | -7 | 15 | -15 |
| -7 | 7 | -15 | 15 |
| 8 | -8 | 16 | -16 |
| -8 | 8 | -16 | 16 |

Fig. 22(f)

IIS(:,:,4)

| | | | |
|---|---|---|---|
| -5 | -21 | 21 | 5 |
| -6 | -22 | 22 | 6 |
| 6 | 22 | -22 | -6 |
| 5 | 21 | -21 | -5 |
| -11 | -23 | 23 | 11 |
| -12 | -24 | 24 | 12 |
| 12 | 24 | -24 | -12 |
| 11 | 23 | -23 | -11 |
| 11 | 23 | -23 | -11 |
| 12 | 24 | -24 | -12 |
| -12 | -24 | 24 | 12 |
| -11 | -23 | 23 | 11 |
| 5 | 21 | -21 | -5 |
| 6 | 22 | -22 | -6 |
| -6 | -22 | 22 | 6 |
| -5 | -21 | 21 | 5 |

Fig. 22(h)

IIS(:,:,2)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -1 | 33 | 41 | 1 | 37 | 45 | -13 | -33 | -45 | 13 | -37 | -41 |
| 1 | 34 | 42 | -1 | 38 | 46 | 13 | -34 | -46 | -13 | -38 | -42 |
| -2 | -33 | -42 | 2 | -37 | -46 | -14 | 33 | 46 | 14 | 37 | 42 |
| 2 | -34 | -41 | -2 | -38 | -45 | 14 | 34 | 45 | -14 | 38 | 41 |
| 1 | 35 | 43 | -1 | 39 | 47 | 13 | -35 | -47 | -13 | -39 | -43 |
| -1 | 36 | 44 | 1 | 40 | 48 | -13 | -36 | -48 | 13 | -40 | -44 |
| 2 | -35 | -44 | -2 | -39 | -48 | 14 | 35 | 48 | -14 | 39 | 44 |
| -2 | -36 | -43 | 2 | -40 | -47 | -14 | 36 | 47 | 14 | 40 | 43 |
| -7 | -33 | -43 | 7 | -37 | -47 | -15 | 33 | 47 | 15 | 37 | 43 |
| 7 | -34 | -44 | -7 | -38 | -48 | 15 | 34 | 48 | -15 | 38 | 44 |
| -8 | 33 | 44 | 8 | 37 | 48 | -16 | -33 | -48 | 16 | -37 | -44 |
| 8 | 34 | 43 | -8 | 38 | 47 | 16 | -34 | -47 | -16 | -38 | -43 |
| 7 | -35 | -41 | -7 | -39 | -45 | 15 | 35 | 45 | -15 | 39 | 41 |
| -7 | -36 | -42 | 7 | -40 | -46 | -15 | 36 | 46 | 15 | 40 | 42 |
| 8 | 35 | 42 | -8 | 39 | 46 | 16 | -35 | -46 | -16 | -39 | -42 |
| -8 | 36 | 41 | 8 | 40 | 45 | -16 | -36 | -45 | 16 | -40 | -41 |

Fig. 22(i)

IIS(:,:,3)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | -3 | -41 | -25 | -17 | -45 | 29 | 3 | 45 | -29 | 17 | 41 |
| -25 | -4 | -42 | 25 | -18 | -46 | -29 | 4 | 46 | 29 | 18 | 42 |
| 26 | 3 | 42 | -26 | 17 | 46 | 30 | -3 | -46 | -30 | -17 | -42 |
| -26 | 4 | 41 | 26 | 18 | 45 | -30 | -4 | -45 | 30 | -18 | -41 |
| -25 | -9 | -43 | 25 | -19 | -47 | -29 | 9 | 47 | 29 | 19 | 43 |
| 25 | -10 | -44 | -25 | -20 | -48 | 29 | 10 | 48 | -29 | 20 | 44 |
| -26 | 9 | 44 | 26 | 19 | 48 | -30 | -9 | -48 | 30 | -19 | -44 |
| 26 | 10 | 43 | -26 | 20 | 47 | 30 | -10 | -47 | -30 | -20 | -43 |
| 27 | 3 | 43 | -27 | 17 | 47 | 31 | -3 | -47 | -31 | -17 | -43 |
| -27 | 4 | 44 | 27 | 18 | 48 | -31 | -4 | -48 | 31 | -18 | -44 |
| 28 | -3 | -44 | -28 | -17 | -48 | 32 | 3 | 48 | -32 | 17 | 44 |
| -28 | -4 | -43 | 28 | -18 | -47 | -32 | 4 | 47 | 32 | 18 | 43 |
| -27 | 9 | 41 | 27 | 19 | 45 | -31 | -9 | -45 | 31 | -19 | -41 |
| 27 | 10 | 42 | -27 | 20 | 46 | 31 | -10 | -46 | -31 | -20 | -42 |
| -28 | -9 | -42 | 28 | -19 | -46 | -32 | 9 | 46 | 32 | 19 | 42 |
| 28 | -10 | -41 | -28 | -20 | -45 | 32 | 10 | 45 | -32 | 20 | 41 |

Fig. 22(j)

IIS(:,:,4)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| -25 | -33 | -5 | 25 | -37 | -21 | -29 | 33 | 21 | 29 | 37 | 5 |
| 25 | -34 | -6 | -25 | -38 | -22 | 29 | 34 | 22 | -29 | 38 | 6 |
| -26 | 33 | 6 | 26 | 37 | 22 | -30 | -33 | -22 | 30 | -37 | -6 |
| 26 | 34 | 5 | -26 | 38 | 21 | 30 | -34 | -21 | -30 | -38 | -5 |
| 25 | -35 | -11 | -25 | -39 | -23 | 29 | 35 | 23 | -29 | 39 | 11 |
| -25 | -36 | -12 | 25 | -40 | -24 | -29 | 36 | 24 | 29 | 40 | 12 |
| 26 | 35 | 12 | -26 | 39 | 24 | 30 | -35 | -24 | -30 | -39 | -12 |
| -26 | 36 | 11 | 26 | 40 | 23 | -30 | -36 | -23 | 30 | -40 | -11 |
| -27 | 33 | 11 | 27 | 37 | 23 | -31 | -33 | -23 | 31 | -37 | -11 |
| 27 | 34 | 12 | -27 | 38 | 24 | 31 | -34 | -24 | -31 | -38 | -12 |
| -28 | -33 | -12 | 28 | -37 | -24 | -32 | 33 | 24 | 32 | 37 | 12 |
| 28 | -34 | -11 | -28 | -38 | -23 | 32 | 34 | 23 | -32 | 38 | 11 |
| 27 | 35 | 5 | -27 | 39 | 21 | 31 | -35 | -21 | -31 | -39 | -5 |
| -27 | 36 | 6 | 27 | 40 | 22 | -31 | -36 | -22 | 31 | -40 | -6 |
| 28 | -35 | -6 | -28 | -39 | -22 | 32 | 35 | 22 | -32 | 39 | 6 |
| -28 | -36 | -5 | 28 | -40 | -21 | -32 | 36 | 21 | 32 | 40 | 5 |

Fig. 22(k)

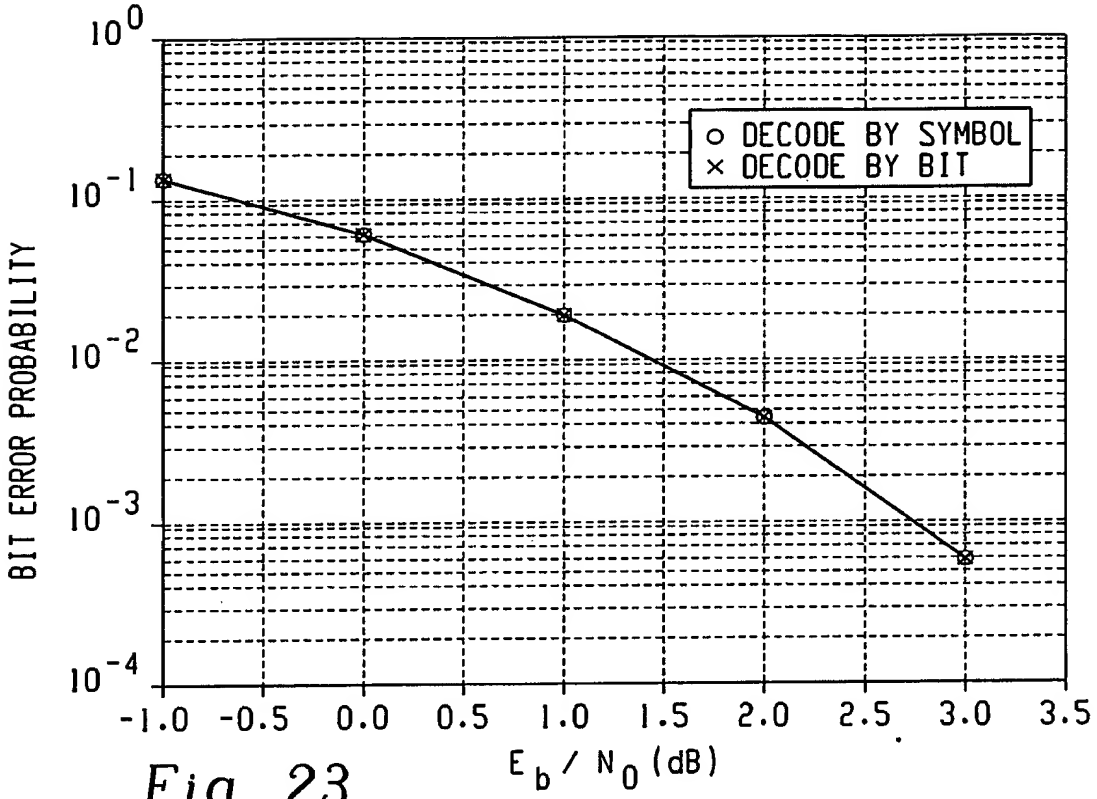
BIT ERROR PROBABILITY
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
$E_b / N_0$ (dB)
o DECODE BY SYMBOL
× DECODE BY BIT

Fig. 23

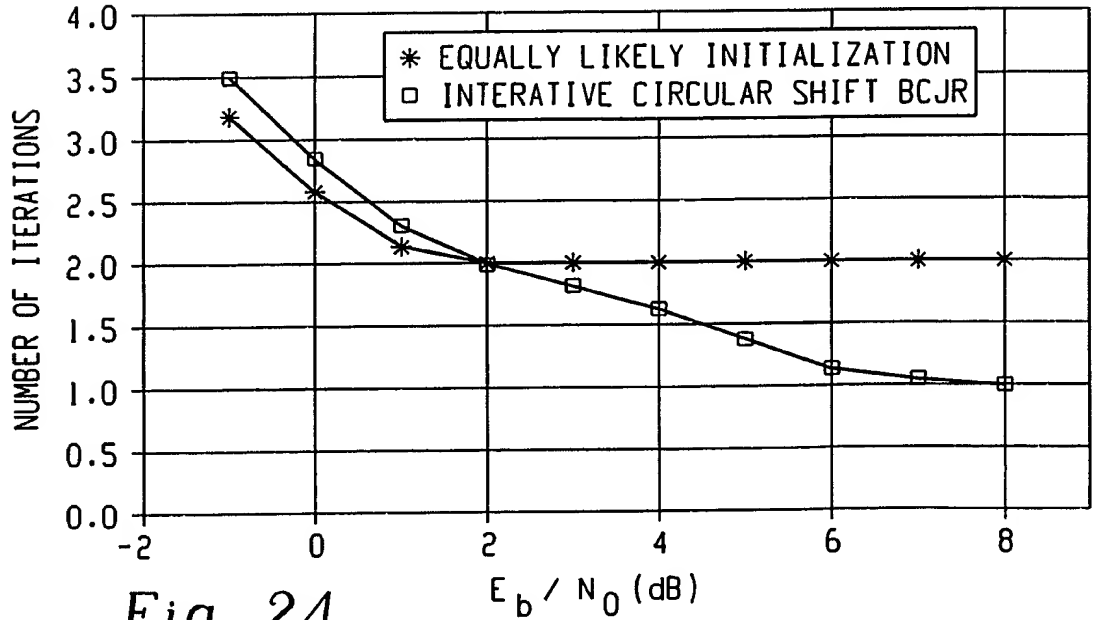
NUMBER OF ITERATIONS
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-2 0 2 4 6 8
$E_b / N_0$ (dB)
* EQUALLY LIKELY INITIALIZATION
□ INTERATIVE CIRCULAR SHIFT BCJR

Fig. 24

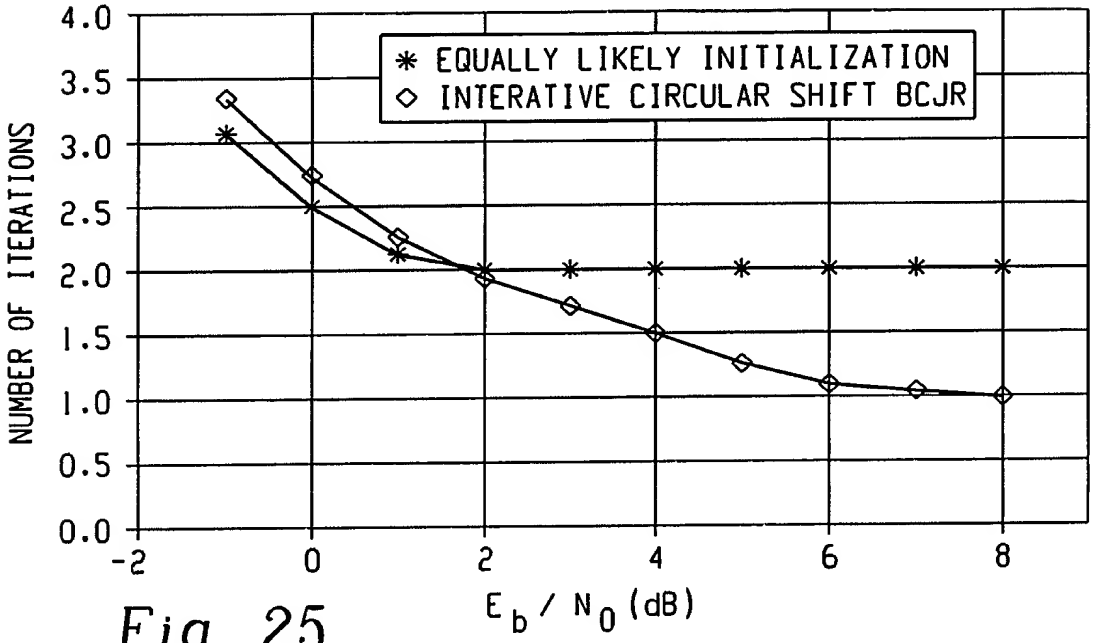
* EQUALLY LIKELY INITIALIZATION
◇ INTERATIVE CIRCULAR SHIFT BCJR
NUMBER OF ITERATIONS
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-2
0
2
4
6
8
$E_b / N_0$ (dB)

Fig. 25

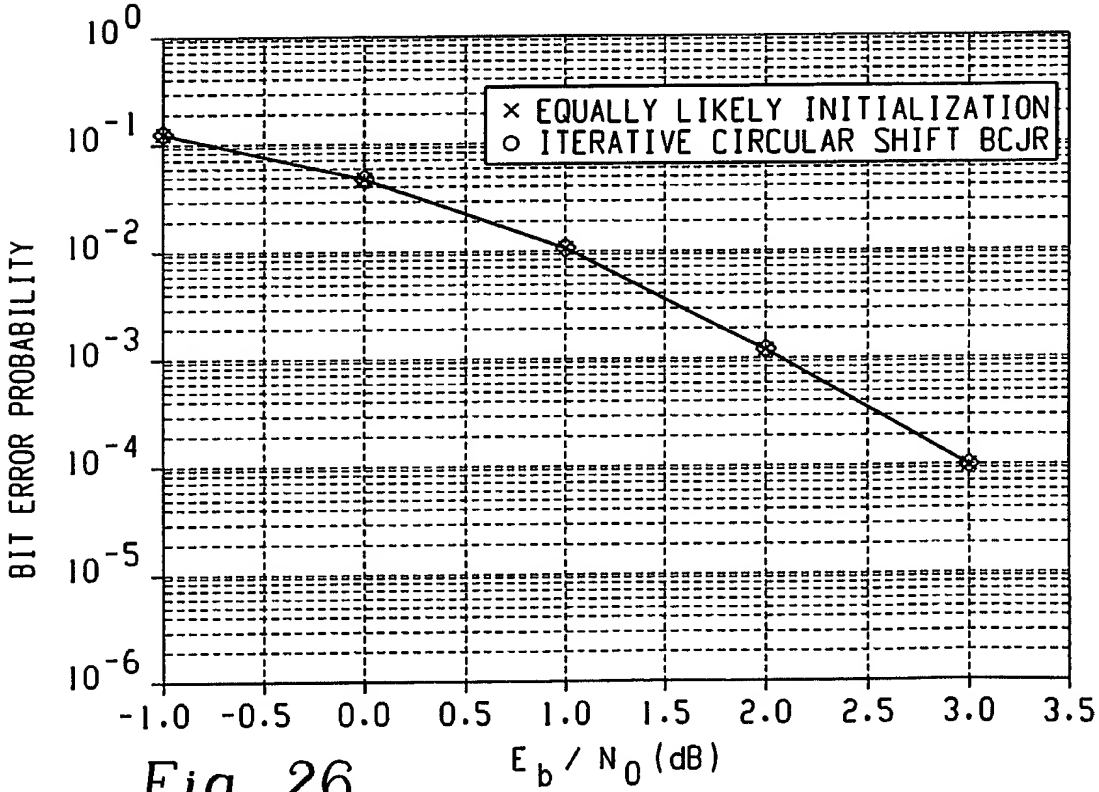
× EQUALLY LIKELY INITIALIZATION
○ ITERATIVE CIRCULAR SHIFT BCJR
BIT ERROR PROBABILITY
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$
-1.0
-0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
$E_b / N_0$ (dB)

Fig. 26

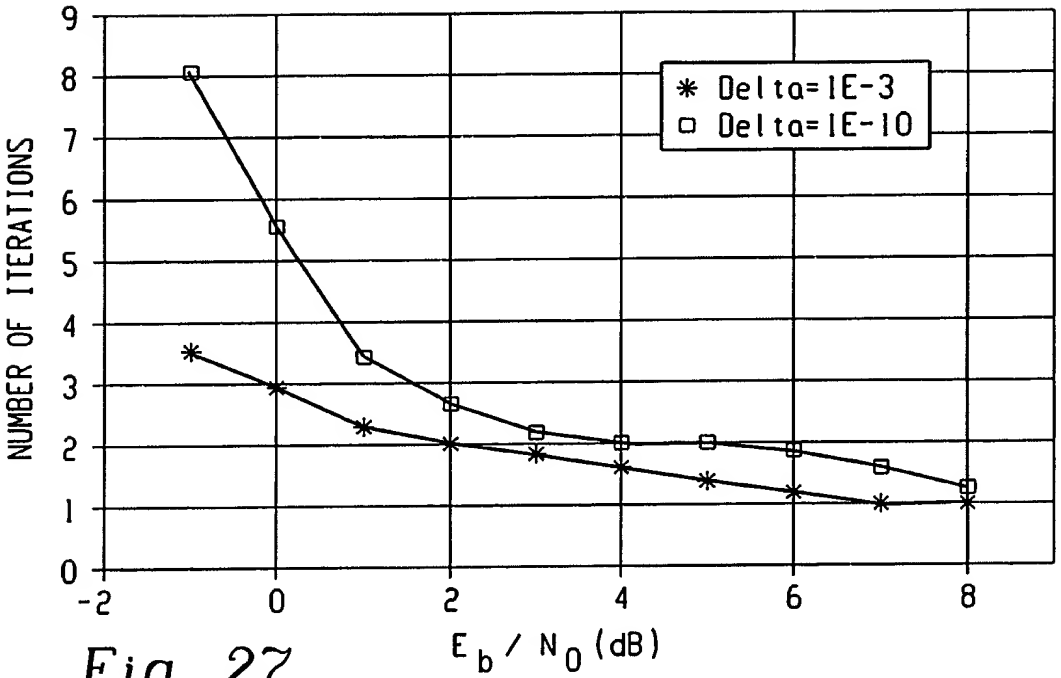
NUMBER OF ITERATIONS
0
1
2
3
4
5
6
7
8
9
-2
0
2
4
6
8
$E_b / N_0$ (dB)
* Delta=1E-3
□ Delta=1E-10

Fig. 27

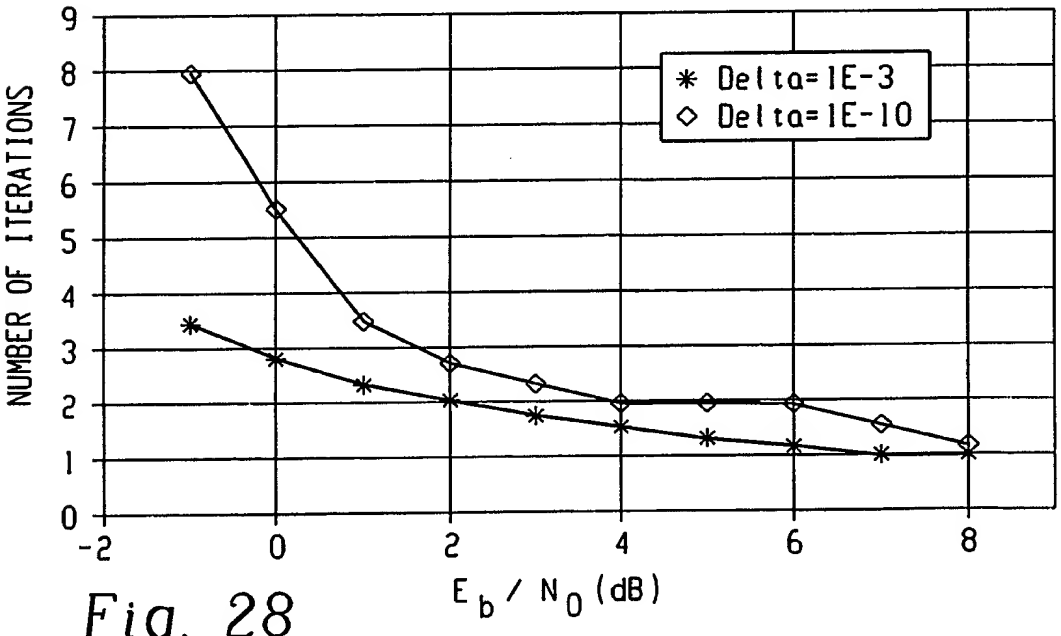
NUMBER OF ITERATIONS
0
1
2
3
4
5
6
7
8
9
-2
0
2
4
6
8
$E_b / N_0$ (dB)
* Delta=1E-3
◇ Delta=1E-10

Fig. 28

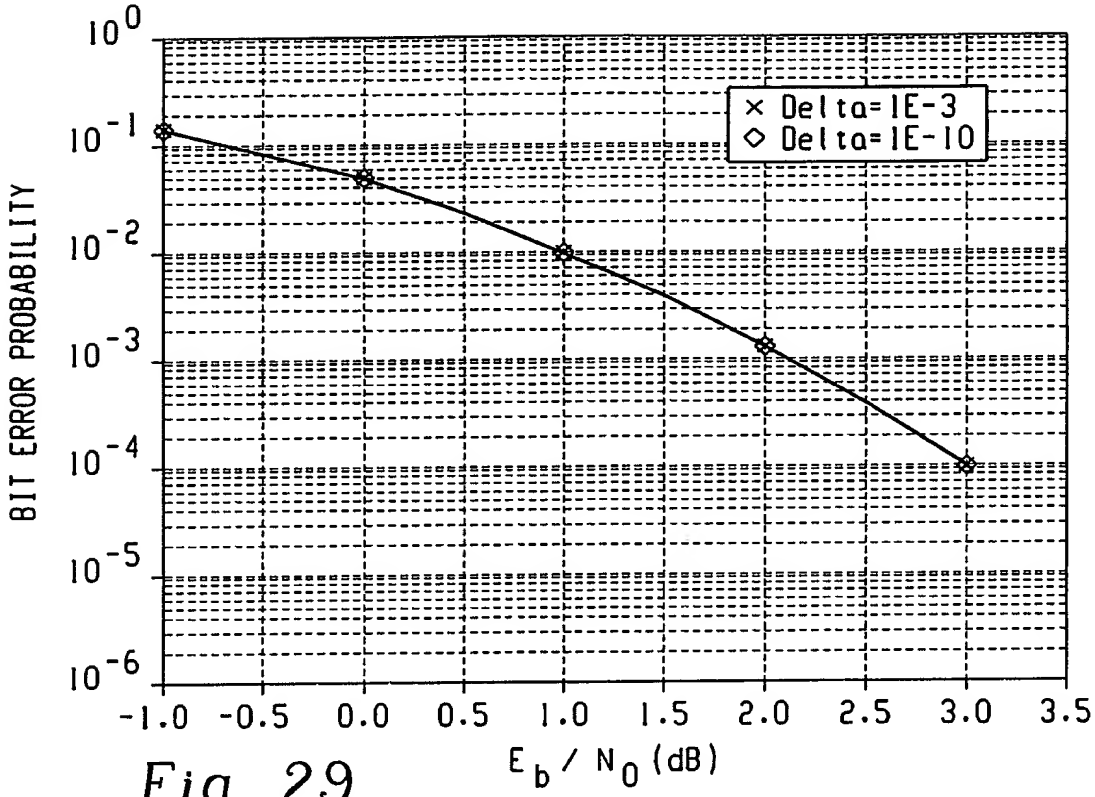
BIT ERROR PROBABILITY
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$
× Delta=1E-3
◇ Delta=1E-10
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
$E_b / N_0$ (dB)

Fig. 29

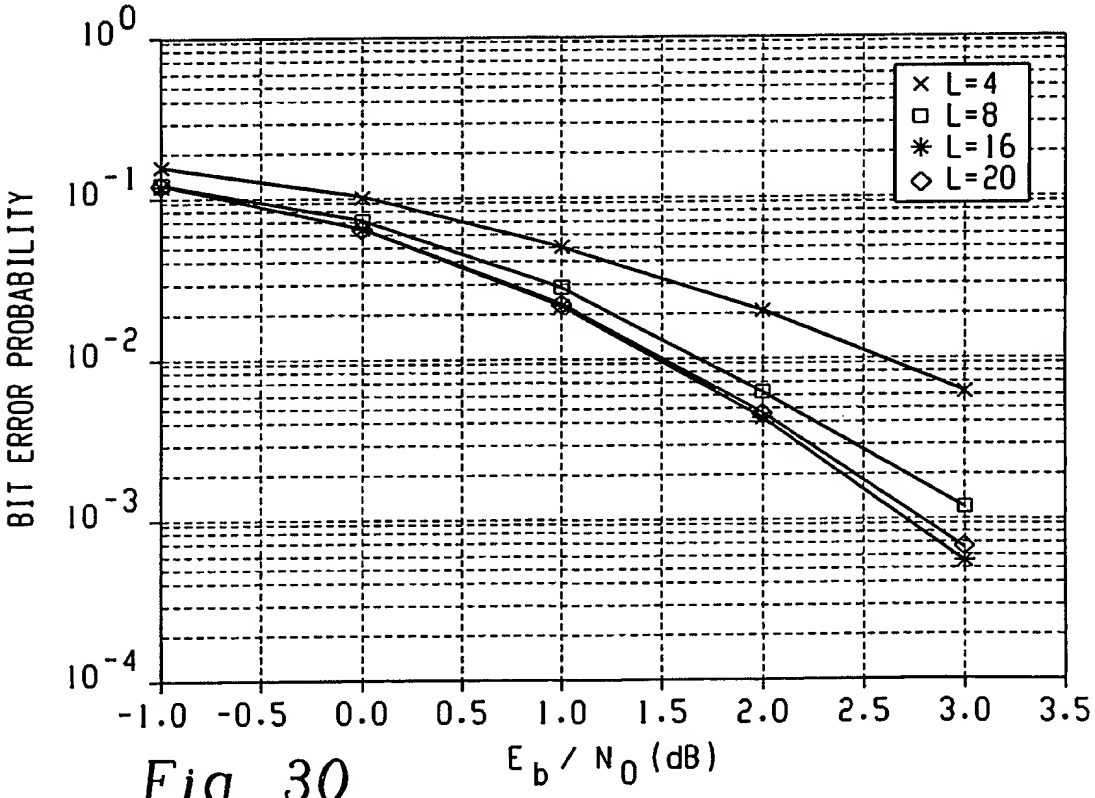
BIT ERROR PROBABILITY
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
× L=4
□ L=8
✱ L=16
◇ L=20
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
$E_b / N_0$ (dB)

Fig. 30

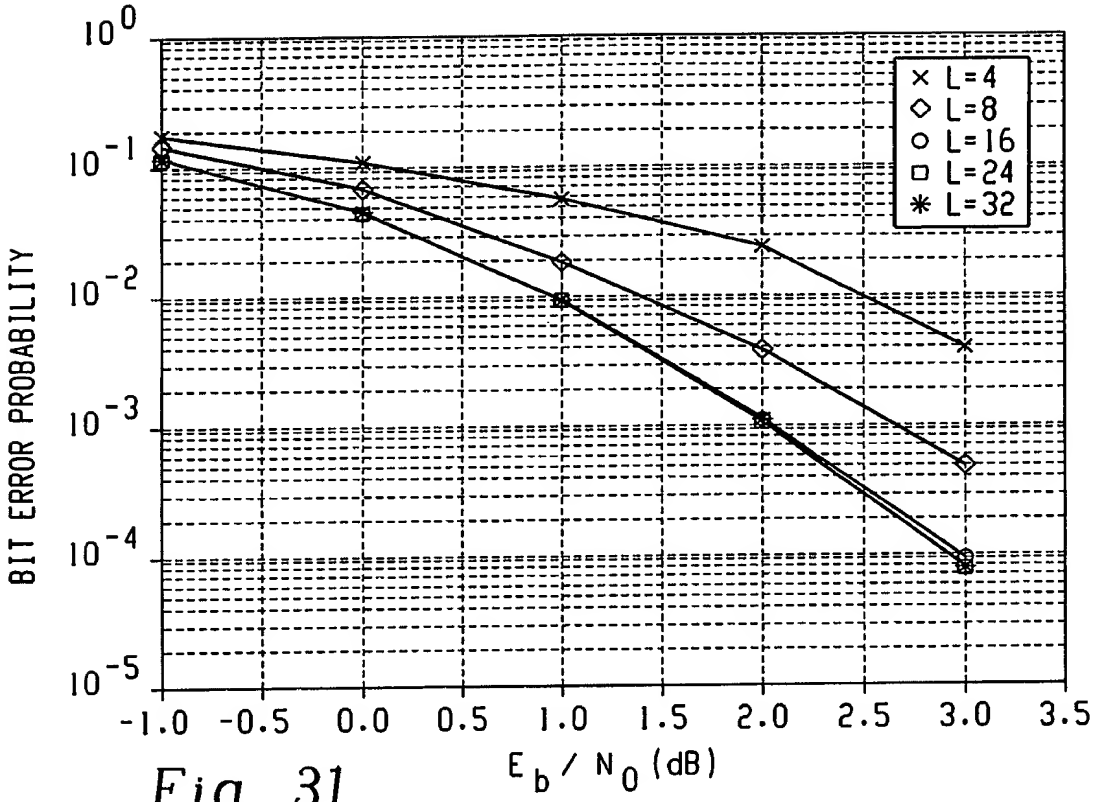
BIT ERROR PROBABILITY
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5
$E_b / N_0$ (dB)
× L=4
◇ L=8
○ L=16
□ L=24
✱ L=32

Fig. 31

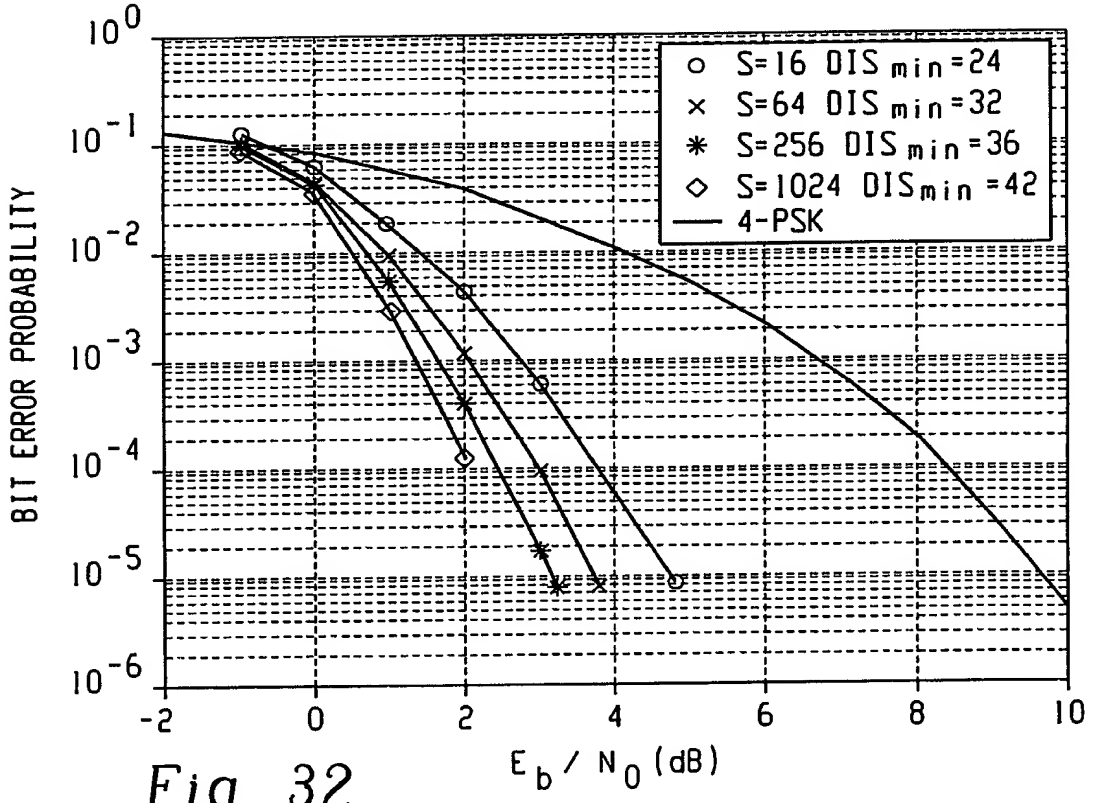
BIT ERROR PROBABILITY
$10^0$
$10^{-1}$
$10^{-2}$
$10^{-3}$
$10^{-4}$
$10^{-5}$
$10^{-6}$
-2 0 2 4 6 8 10
$E_b / N_0$ (dB)
○ S=16 DIS min=24
× S=64 DIS min=32
✱ S=256 DIS min=36
◇ S=1024 DIS min=42
— 4-PSK

Fig. 32

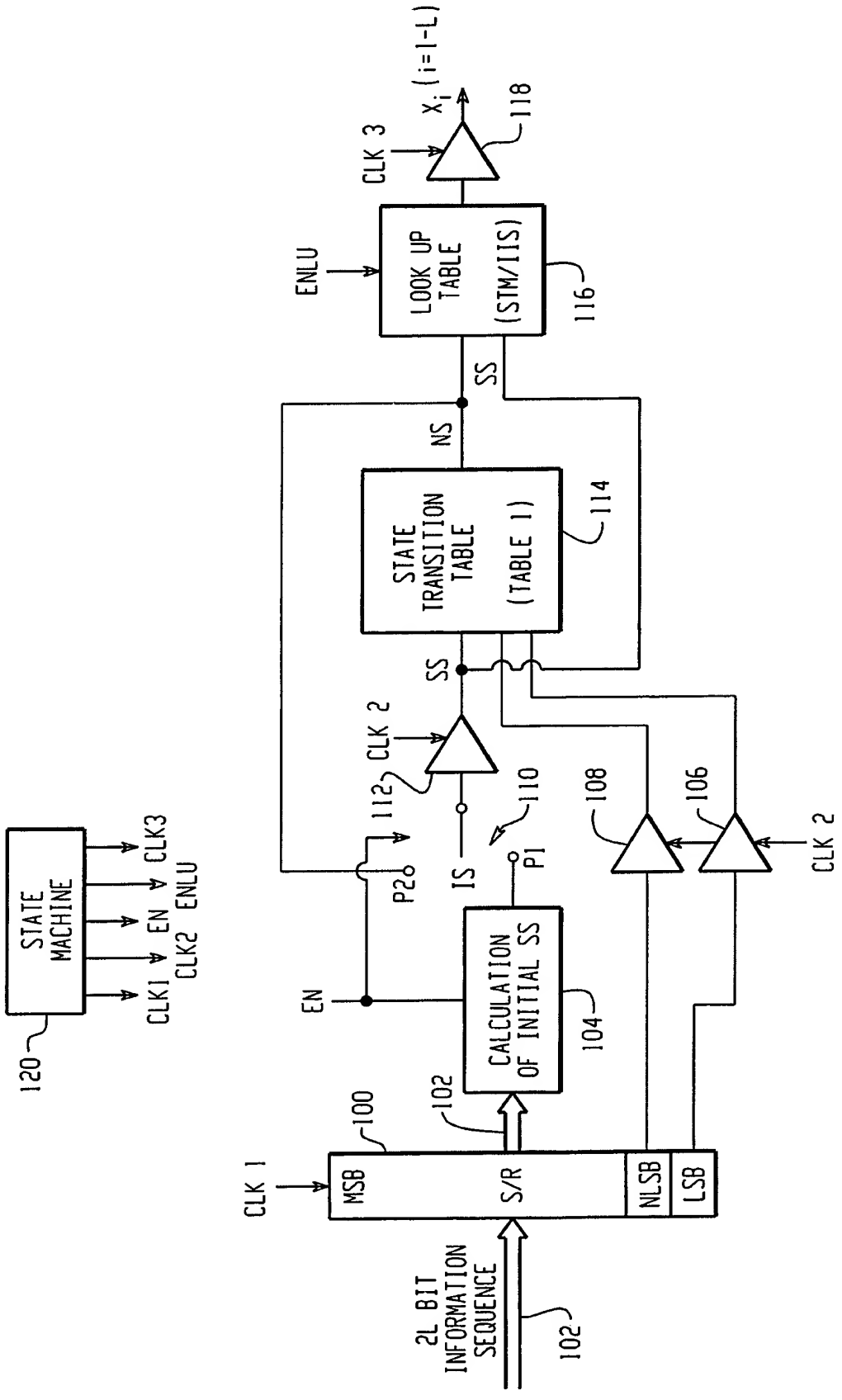
$X_i$ (i=1-L)
118
CLK 3
ENLU
LOOK UP TABLE (STM/IIS)
116
SS
NS
STATE TRANSITION TABLE (TABLE 1)
114
SS
CLK 2
112
110
108
106
CLK 2
P2
IS
P1
EN
CALCULATION OF INITIAL SS
104
102
100
CLK 1
MSB
S/R
NLSB
LSB
2L BIT INFORMATION SEQUENCE
102
STATE MACHINE
120
CLK1
EN
CLK2
ENLU
CLK3

Fig. 33

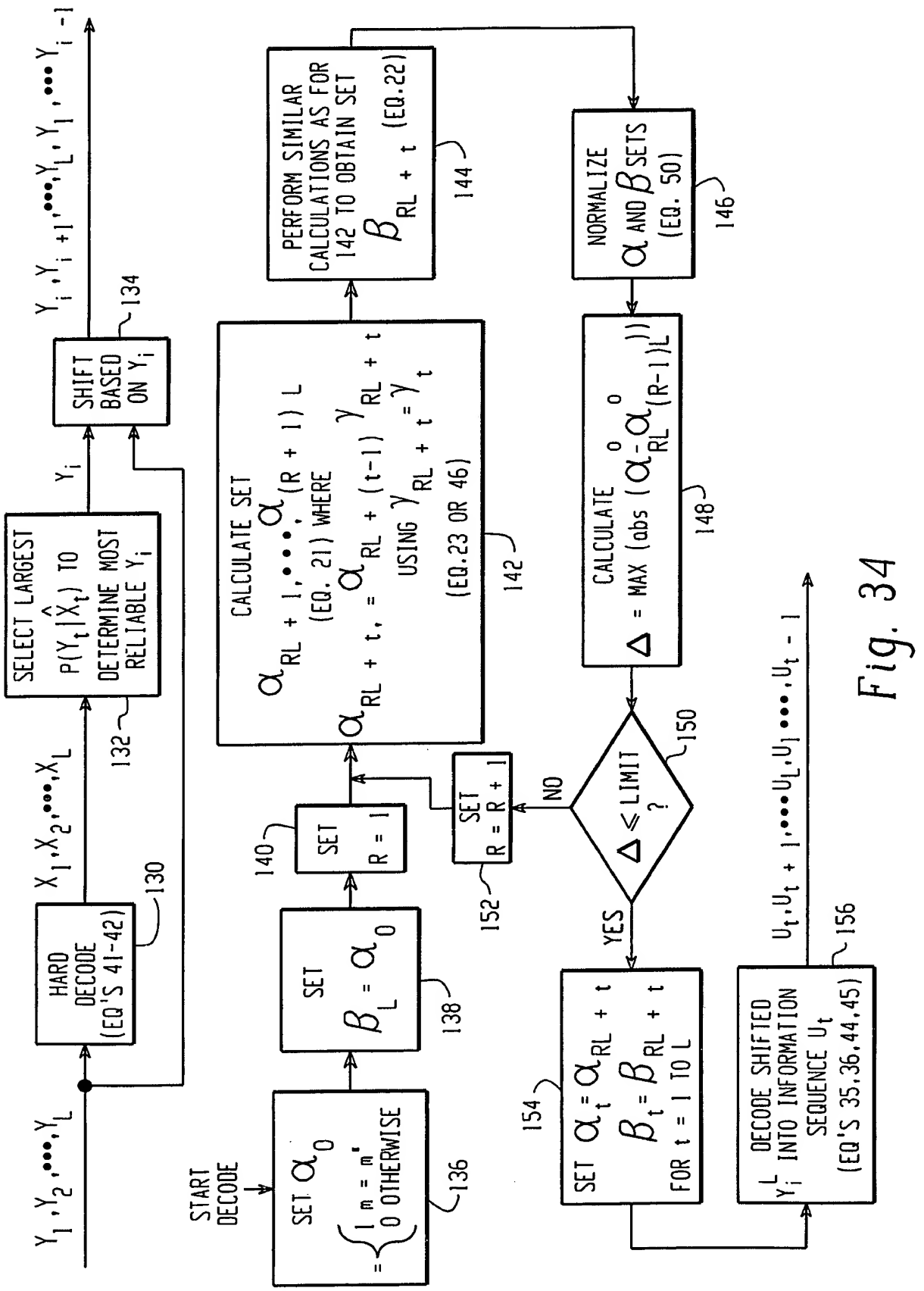
START DECODE
SET $\alpha_0$ = 1 m = m' 0 OTHERWISE
136
SET $\beta_L = \alpha_0$
138
SET R = 1
140
CALCULATE SET $\alpha_{RL+1}, \cdots, \alpha_{(R+1)L}$ (EQ. 21) WHERE $\alpha_{RL+t'} = \alpha_{RL+(t-1)} \gamma_{RL+t}$ USING $\gamma_{RL+t} = \gamma_t$ (EQ.23 OR 46)
142
PERFORM SIMILAR CALCULATIONS AS FOR 142 TO OBTAIN SET $\beta_{RL+t}$ (EQ.22)
144
NORMALIZE $\alpha$ AND $\beta$ SETS (EQ. 50)
146
CALCULATE $\Delta = \text{MAX}(\text{abs}(\alpha - \alpha^0_{RL}{}^0_{(R-1)L}))$
148
$\Delta \leq$ LIMIT ?
150
NO
SET R = R + 1
152
YES
SET $\alpha_t = \alpha_{RL+t}$ $\beta_t = \beta_{RL+t}$ FOR t = 1 TO L
154
DECODE SHIFTED $Y_i^L$ INTO INFORMATION SEQUENCE $U_t$ (EQ'S 35,36,44,45)
156
$U_t, U_{t+1}, \cdots U_L, U_1 \cdots, U_{t-1}$
HARD DECODE (EQ'S 41-42)
130
$X_1, X_2, \cdots, X_L$
SELECT LARGEST $P(Y_t|\hat{X}_t)$ TO DETERMINE MOST RELIABLE $Y_i$
132
$Y_i$
SHIFT BASED ON $Y_i$
134
$Y_i, Y_{i+1}, \cdots, Y_L, Y_1, \cdots Y_{i-1}$
$Y_1, Y_2, \cdots, Y_L$

Fig. 34